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APOLLO TRAINING PLAN
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Contract NAS9-150

Reissued 1 February 1965

Paragraph 3.7, Exhibit I

NORTH AMERICAN AVIATION, INC.
SPACE and INFORMATION SYSTEMS DIVISION

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FOREWORD

This reissue of the Apollo Training Plan for the Apollo spacecraft is submitted in accordance with Paragraph 3.7, Exhibit I, of the Definitive Contract NAS9-150.

The report reflects schedule data provided in Apollo Master Development Schedule 8 (Revision 2), dated 23 December 1964 for Block I and Block II. The dates shown for the availability of the Apollo mission simulators for training are scheduled dates combined with planned installation and checkout periods.

The next reissue of this report is scheduled for publication on 1 June 1965.

TECHNICAL REPORT INDEX/ABSTRACT

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ABSTRACT

The Apollo Training Plan provides an overall plan for implementing and accomplishing Apollo training for NASA personnel. The total contents of the plan constitutes a gross recommendation to NASA by S&ID. S&ID participation within the framework of the plan is identified and discussed wherever pertinent or applicable.

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1.0 INTRODUCTION

1.1 PURPOSE

It is the purpose of the Apollo Training Plan to provide an overall plan for implementing and accomplishing Apollo training for NASA personnel. The total contents of the plan constitute a gross recommendation to NASA by S&ID. S&ID participation within the framework of the plan is identified and discussed wherever pertinent or applicable.

1.2 SCOPE

The results of training requirements research and of training planning are reported. These results include the definition of training requirements, identification and description of recommended training courses, establishment of training schedules, recommendations for utilization of Apollo training equipment, and provision of status information relevant to the detailed training requirements research in process at the S&ID Downey facility.

S&ID training services for NASA are described. Information also is provided concerning the training courses available, the training services accomplished, and other training services presently scheduled.

Training equipment and trainer instructor handbooks are discussed in considerable detail. Information provided relevant to training equipment includes a functional description of each Apollo trainer; the scope, approach, and format of trainer instructor handbooks; and trainer and handbook scheduling information.

In equipment terms, the plan encompasses all training directly related to the Apollo spacecraft (command module, service module, launch escape system) and interfacing ground support equipment.

Training requirements and services defined in the plan are provided for all NASA personnel requiring training. Emphasis has been placed on training: Apollo flight crews, Flight Crew Support Division (FCSD) personnel, Flight Control Division (FCD) mission control teams and support staffs, and engineers and technicians involved in the Apollo test program at Cape Kennedy (ETR) and the White Sands Missile Range (WSMR).

1.3 PROGRAM PLAN

Scheduling of Apollo training in this plan is in accordance with Apollo Master Development Schedule 8 (Revision 2), which includes a requirement for manned flight capability in Apollo Spacecraft 012. The heaviest training load and the most critical training schedules occur in achieving an initial NASA capability to successfully launch, fly, and recover manned Spacecraft 012.

Figure 1-1 provides an overall Apollo training program schedule. Critical dates affecting overall training planning and accomplishment are: Spacecraft 012 delivery date to ETR, automatic checkout equipment (ACE) operational date at ETR, Spacecraft 012 launch date, Manned Spacecraft Control Center (MSCC) and simulation checkout and training system (SCATS) operational dates, and Apollo training equipment availability dates.

1.4 S&ID SERVICES AND SUPPORT

Present S&ID support of Apollo training includes the development of Apollo training equipment, the preparation of trainer instructor handbooks, the preparing and conducting of technical briefings on spacecraft systems, the publication of the Training Plan, and the carrying out of the research and study required in plan preparation. Apollo training services for NASA are conducted by the same staff that plans and conducts Apollo systems training for S&ID personnel. Visibility to all S&ID services in the Apollo training area and access to S&ID Apollo training services and materials can be arranged through the cognizant project officer in MSC-ASPO.

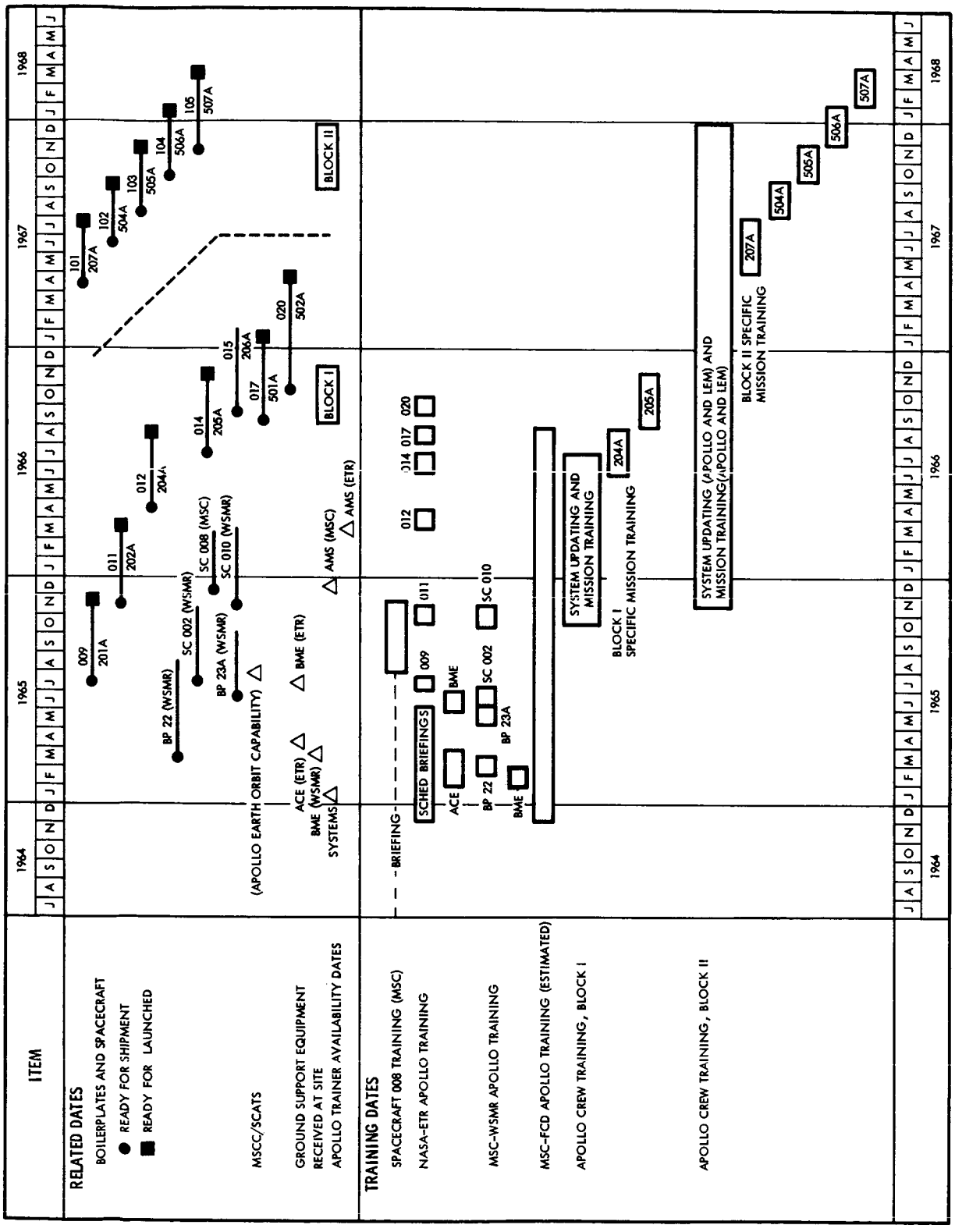

Figure 1-1. Apollo Training Schedule

2.0 FLIGHT CREW AND FCSD

2.1 FLIGHT CREW TRAINING REQUIREMENTS

Training of flight crew personnel involves careful planning and programming in order to achieve maximum crew proficiency within the relatively limited time available. Flight crew training is to be accomplished in four general phases: Technical Briefings and Program Participation, Apollo Procedure Training, Apollo Typical Mission Training, and Specific Mission Training. These are summarized in Table 2-1.

Table 2-1. Flight Crew Training Phases

Phase	Content
Technical Briefings and Program Participation	1. Academic instruction and practical work in the basic sciences of space flight related to the Apollo missions include: study of interplanetary and stellar astronomy; space physics and biophysics; orbital mechanics, trajectories, and space navigation; selenography; and computer technology 2. Participation in planning spacecraft, crew, and mission requirements 3. Involvement in astronaut system reviews 4. Technical briefings on spacecraft systems 5. Technical briefings on launch vehicle systems 6. Participation as test subjects in Apollo Engineering simulation studies 7. Training in centrifuge, pressure chamber, etc. 8. Recovery and survival training 9. Work in assigned areas of program technical responsibility

[redacted]

Table 2-1. Flight Crew Training Phases (Cont)

Phase	Content
Apollo Procedures Training	1. Part Task and Crew Procedures Training. Includes introduction to the cockpit environment; normal crew procedures; and application of alternate modes, redundant systems, and manual overrides. NOTE: The System Analysis and Repair Training is no longer identified as a required phase of training due to CCA-213, which removed the IFTS and many system spare parts. The Part Task and Crew Procedures Training will, through the use of simulated spacecraft malfunctions, provide a need for system analysis to determine required crew action.
Apollo Typical Mission Training	1. Typical Mission Situation Training. Includes crew procedures for all major mission events, crew judgments, variations in procedures in dealing with mission situations and contingencies, and procedures and situations in working interface with manned spacecraft flight network (MSFN)-MSCC.
Specific Mission Training	1. Final refinement and practice of specific mission plan and procedures 2. Participation in preflight test and checkout of the spacecraft 3. Supplementary specific mission training in such activities as egress and recovery, scientific experiments and data gathering, lunar surface operations, specific mission navigation, etc. 4. Practice of the specific mission with MSCC-SCATS using the Apollo mission simulator (AMS)-SCATS interface capability 5. Practice and evaluation of possible specific mission contingencies

2.2 FCSD TRAINING REQUIREMENTS

S&ID also anticipates a need for and recommends a series of technical briefings and system training courses for FCSD personnel. Such training is required to provide FCSD personnel with Apollo spacecraft background for technical participation in spacecraft development; preparation of mission plans and crew procedures for successful Apollo missions; and operation and effective utilization of Apollo training equipment.

S&ID technical briefings on Apollo spacecraft systems for FCSD have been initiated. These are discussed in Paragraph 2.5 of this report.

System areas for which FCSD requires detailed training, and a description of such training, are included in Table 2-2.

Table 2-2. FCSD Training Requirements

Type of Training	Training Required
Crew procedures	In order to effectively plan Apollo missions and prepare detailed crew procedures, FCSD personnel require a working familiarity with spacecraft controls and indicators and with the crew compartment environment. A course of training in crew procedures for non-crew FCSD personnel is recommended.
Spacecraft systems training: Stabilization and control system Propulsion systems Communications and data system Electrical power system	In order to effectively plan, measure, and evaluate crew capabilities to deal with system contingencies in mission situations, FCSD personnel require training in the crew test and analysis capability. The requirements include: detailed system theory of operation, MSFN data sampling capabilities, and procedures for diagnosing system malperformance and for taking corrective action. A series of spacecraft systems training courses is recommended.

Table 2-2. FCSD Training Requirements (Cont)

Type of Training	Training Required
Guidance and navigation system	
Environmental control system	
Structures and crew equipment	
Launch escape, earth landing and emergency detection systems	

2.3 OVERALL PROGRAM PLAN AND SCHEDULE

The scope of specific S&ID programming recommendations for Apollo flight crew and FCSD training includes: system technical briefings, Apollo typical mission training (flight crew), specific mission training—flight crew, crew procedures training (FCSD), and spacecraft systems training (FCSD), as defined in Tables 2-1 and 2-2. A schedule to accomplish the program is provided in Figure 2-1. The schedule is constrained by the following critical dates.

Critical dates in the scheduling of flight crew and FCSD training are the Spacecraft 012 launch date, the MSCC-SCATS operational date, and Apollo training equipment availability dates. The training equipment availability dates are derived from the scheduled shipping dates and the planned installation and checkout time.

The scheduling of Apollo mission training is premised on training all Block I flight crews in an initial group. This group includes prime and back up crew personnel for Spacecraft 012 and 014. Subsequent reiteration of the training would then be based on transfer of Gemini crew members and/or designation of new astronaut candidates. The reiteration for Block II flight crews has been included in the schedule (Figure 2-1).

It is recognized that NASA must have the flexibility to respond to many requirements which may influence its particular approach to flight crew

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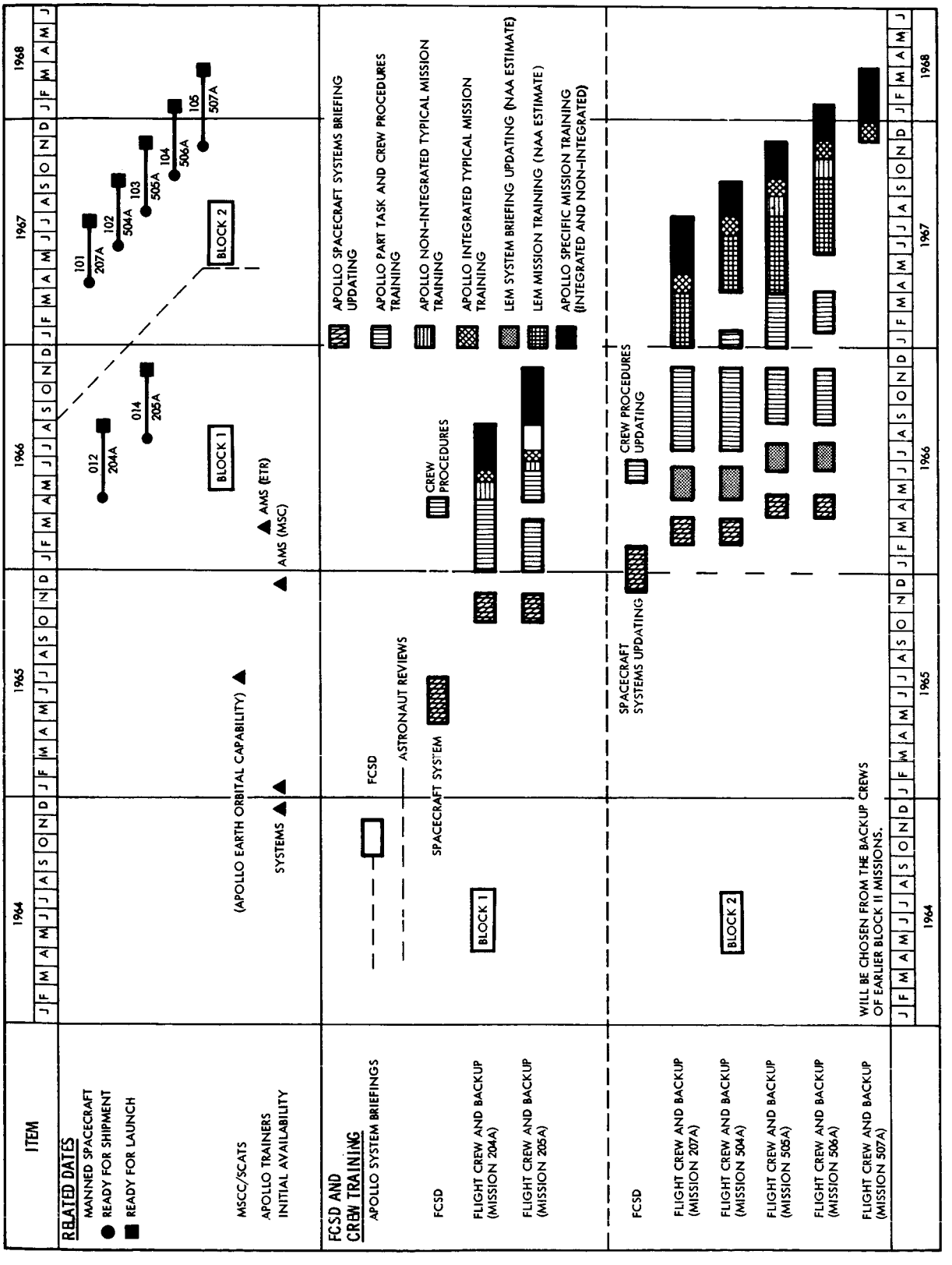


Figure 2-1. Flight Crew and FCSD Training Schedule

training. Accordingly, training milestones have been identified for each type of training. Each milestone is associated with a different level of desired flight crew proficiency for that type of training. Using these milestones as indicators of increasing flight crew proficiency, several different flight crew training approaches have been identified and are the subject of Section 2.12. A shorthand notation has been assigned for each type of training milestone. These are as follows:

APTM - Apollo Part Task Training Milestones
ACPM - Apollo Crew Procedures Training Milestones
ATMM - Apollo Typical Mission Training Milestones
AITM - Apollo Integrated Typical Mission Training Milestones
ASMM - Apollo Specific Mission Training Milestones
AISM - Apollo Integrated Specific Mission Training Milestones
ASSM - Apollo Spacecraft System Briefing Milestones
ATPM - Apollo Test Participation Training Milestones
ASCM - Apollo Scientific Training Milestones
AENM - Apollo Environmental Training Milestones

2.4 FLIGHT CREW PROGRAM PARTICIPATION

Table 2-1 includes a general outline of how flight crew members are being prepared for mission training and how they are participating in the overall Apollo program. A program background of the magnitude described in Table 2-1, Technical Briefings and Program Participation, precludes any requirement for familiarization or basic sciences background training as part of the Apollo mission training curriculum.

Individual flight crew members of the Apollo Group have been assigned to specific areas of the program which they must monitor. Each flight crew member represents the other members of the Apollo group in his assigned area and is therefore able to brief them to the extent of his participation. However, there are certain test program activities in which each Block I flight crew, prime and backup, should have a personal representative participating. Some of these activities are listed below. It should be noted that the integrated tests using ACE at Downey and the Field Operations at the Eastern Test Range (ETR) are considered to be part of specific training and therefore should involve only the flight crew and backup assigned to the spacecraft for that mission.

SC 001 service module at PSDF: hot firing of service propulsion engine

SC 008 at MSC: thermal vacuum test

All future test flights, including:

1. BP-23A command module for pad abort
2. BP-22 for high-altitude abort
3. SC 002 for power-on tumbling abort
4. BP-16 and BP-26 for micrometeoroid experiments
5. SC 009 and SC 011 for supercircular entry with a Saturn IB booster configuration
6. SC 012 for first Apollo manned flight

Some completion milestones for flight crew test participation are given as follows:

ATPM-1 Each flight crew has confidence in the reliability of the spacecraft systems through participation in the systems test program.

ATPM-2 Each flight crew has confidence in the reliability of the boost vehicles systems through participation in the system test and flight test programs.

ATPM-3 Each flight crew has confidence in the checkout program as an adequate means of determining status of spacecraft systems prior to launch.

ATPM-4 Each flight crew has confidence in the checkout program as an adequate means of determining status of boost vehicle systems prior to launch.

ATPM-5 Each flight crew member is personally aware of the specific systems differences between the Apollo mission simulator and his assigned spacecraft through participation in the various checkout and test functions performed at KSC on his spacecraft.

As the test program for Spacecraft 012 and 014 is further defined, S&ID Apollo Training intends to identify the required flight crew participation to satisfy training milestones ATPM-1 through ATPM-5.

2.5 TECHNICAL BRIEFINGS

Apollo system technical briefings are presently provided for both FCSD and the astronauts by S&ID. A substantial number of such briefings have already been accomplished.

System technical briefings for astronauts are being presented in relation to the astronaut system reviews with S&ID-Apollo Engineering. Prior to the astronaut system review, a training briefing is prepared, cleared with Engineering, and presented to the astronauts at MSC. The S&ID instructor who prepares and presents the briefing is present at the astronaut system review to assist the astronauts in interpreting data. The procedure has been highly successful from the standpoint of both the astronaut and S&ID Apollo Engineering. The present briefing and system review participation involves a limited number of astronauts, each working in his area of specific program assignment.

Scheduling of system technical briefings for both FCSD and the astronauts has been on an as-requested basis. Briefings continue to be available upon reasonable notice from MSC-ASPO. Courses available from S&ID are the subject of Section 8.0 of the plan. Table 2-3 includes the system technical briefings presented to FCSD personnel.

Prior to the initiation of Apollo mission training, it will be necessary to bring all flight crew members to a common level of understanding of spacecraft systems. The spacecraft systems briefings scheduled for this purpose, identified in Figure 2-1, provide coverage for all spacecraft systems. Apollo system trainers will be used in this phase of crew training. Training milestones associated with this type of training are given below.

ASSM-1. Each flight crew member has a fairly complete knowledge of each spacecraft system configuration, the physical interfaces between the spacecraft systems, and the physical significance of each spacecraft system display within the command module.

ASSM-2. Each flight crew member has a fairly complete knowledge of each spacecraft system configuration, the physical interfaces between the spacecraft systems, the physical significance of each spacecraft system display within the command module, and individual spacecraft systems signal flow when spacecraft system malfunctions are introduced into the system.

Table 2-3. System Technical Briefings for FCSD Personnel

System	System Technical Briefings		
	Date	Time (hr)	Students
Apollo familiarization	17 Jul 63	12.0	16
Apollo familiarization	12 Sept 63	12.0	6
Stabilization and control	16 Sept 63	20.0	7
Stabilization and control	16 Sept 63	20.0	13
Stabilization and control	14 Oct 63	6.5	2
Stabilization and control	4 Nov 63	20.0	3
Propulsion	27 Nov 63	6.5	2
Electrical power	2 Dec 63	8.0	2
Environmental control	7 Jan 64	12.0	2
Communications and instrumentation	9 Jan 64	16.0	3
Launch escape and earth landing	21 Jan 64	14.0	5
Stabilization and control	12 Oct 64	32.0	27
Propulsion	22 Oct 64	16.0	17
Electrical power	28 Oct 64	7.0	13
Environmental control	30 Oct 64	16.0	7
Sequential events control	9 Nov 64	12.0	20
Telecommunications	13 Nov 64	20.0	14
Structural and mechanical	20 Nov 64	8.0	12
Crew systems	24 Nov 64	8.0	9

2.6 PART TASK AND CREW PROCEDURES TRAINING

Part task training is the first type of training to be accomplished using the Apollo mission simulator (AMS). Part task exercises involve a single astronaut in the AMS for purposes of accomplishing basic manipulative skills and basic procedures training. Crew procedures training is the second type of training to be accomplished using the AMS. Crew procedure exercises involve two or three astronauts in the trainer for training in logical groups of tasks.

The requirements for these types of training have been identified in several previously published revisions of this Training Plan. Detailed requirements also have been identified in two training analysis outputs. These are the Crew Training Units and the Apollo Part Task Trainer Exercise Plan. The APTT Exercise Plan is the subject of Section 2.10 of this Training Plan. The crew training units were developed by the S&ID Training Analysis Section

as training requirements for spacecraft systems operation and crew procedures training. These training units identified the need for specific learn-and-practice training. However, it was noted that much of the required training consisted of practice on various crew procedures. The emphasis on procedures rather than systems led S&ID to abandon the organization of these units and follow more closely the organization of the APTT Exercise Plan as further definition of this training continued.

Next, a preliminary syllabus was completed for the part task and crew procedures training. This syllabus follows the organization of the APTT Exercise Plan and includes learning requirements identified previously in the crew training units. The part task and the crew procedures training syllabi are written from the standpoint of one crew member and one flight crew, respectively. Ineffective training would result if a given crew member or flight crew spent an extended time in the trainer. Therefore, it is desirable to schedule a group of flight crew members to receive part task and crew procedures training during the same period. It is recommended that twelve flight crew members form the group scheduled for Block I training. This will provide crew personnel to support the two scheduled manned missions of Block I. The recommended schedule for flight crew training (Figure 2-1) is based on this assumption. Then, using these preliminary syllabi, the following summary time requirements were developed (Table 2-4).

Table 2-4. Summary Time Requirements for Part Task and Crew Procedures Training

Type of Training	Flight Crew and Backup for Mission	Number of Students	Total Trainer Time (hrs)	Total Classroom Time per Crew
Part task exercises	204A & 205A	12	936	50
Crew procedures exercises	204A & 205A	12	426	—

The trainer time per flight crew member provides considerable practice in part task exercise and two complete crew procedure exercise runs per flight crew member for each spacecraft station. For both types of exercises, time has been allowed for the use of simulated spacecraft malfunctions.

Finally, the means by which to operationally accomplish part task and crew procedures training on the AMS is now being developed for the

AMS Instructor Handbook. This handbook, the subject of Section 7, identifies training exercises consisting of training sessions and training runs. Some of the partially developed sessions are identified in Appendix B.

The training milestones for part task and crew procedures training are as follows:

APTM-1. Each flight crew member has been introduced to each all-go one-man activity and can participate in the all-go crew procedures training, but with limited training efficiency (Block I).

APTM-2. Each flight crew member understands, and can perform fairly well, all one-man activities associated with an all-go Block I mission and is prepared to go ahead with crew procedures training involving only all-go procedures (Block I).

APTM-3. Each flight crew member has been introduced to each all-go one man activity and recognizes the need for use of alternate systems and procedures through a light overview of the simulated spacecraft malfunction. Each flight crew member can participate in the complete crew procedures training effort, but with limited training efficiency (Block I).

APTM-4. Each flight crew member understands, and can perform fairly well, all one-man activities, including use of alternate systems and procedures, by practice involving approximately one-half of the simulated spacecraft system malfunctions. Each flight crew member is prepared to participate in the complete crew procedures training (Block I).

APTM-5. Each flight crew member understands, and can perform well, all one-man activities, including use of alternate systems and procedures, by practice involving 75 percent of all identified simulated spacecraft system malfunctions (Block I).

APTM-6. Each flight crew member understands, and can perform well, all alternate systems and procedures required by training with all identified part task contingencies. Training to accomplish this milestone would occur after completion of all-go part task and crew procedures training and would be followed by crew procedures contingency training (Block I).

ACPM-1. Each astronaut, as a member of a flight crew, is acquainted with each of the all-go crew activities for Block I missions. Each flight crew member has very little knowledge or skill to accomplish the procedural interface between individual crew members.

ACPM-2. Each astronaut, as a member of a flight crew, understands, and can perform fairly well, all spacecraft procedures associated with an all-go Block I mission.

ACPM-3. Each astronaut, as a member of a flight crew, is acquainted with the spacecraft procedures associated with the Block I manned missions and recognizes the need for use of alternate systems and procedures through a light overview of the simulated spacecraft malfunctions.

ACPM-4. Each astronaut, as a member of a flight crew, understands, and can perform fairly well, all spacecraft procedures, including use of alternate systems and procedures, by practice involving approximately one-half of the simulated spacecraft system malfunctions.

ACPM-5. Each astronaut, as part of a flight crew, understands, and can perform well, all spacecraft procedures, including use of alternate systems and procedures, by programming 75 percent of all identified simulated spacecraft systems malfunctions for crew procedures training.

ACPM-6. Each astronaut, as part of a flight crew, can perform well with all alternate systems and procedures required by programming all identified simulated spacecraft system malfunctions for crew procedures training. Training to accomplish this milestone would occur after completion of at least the all-go part task and crew procedures training.

The training required to achieve a given milestone is defined in terms of training exercises, sessions, and runs. Table 2-5 provides a partial identification on the number of training runs required for achieving the various part task training milestones. Some of these training runs are described in Appendix B.

2.7 TYPICAL MISSION TRAINING

Typical mission training is the next type of flight crew training that should follow the crew procedures training. This training now exposes

Table 2-5. Required Part Task Training Runs (Partial)

Training Activity or Training Purpose	Training Milestones	APTM-1	APTM-2	APTM-3	APTM-4	APTM-5	APTM-6
PT 5.1 Launch and ascent procedures (Sta 1)							
Run 1		1	1	2	2	2	
Run 2			2	1	2	3	4
Run 3					1	2	2
Run 4					1	2	2
Run 5			1	1	2	2	3
PT 5.2 LES aborts (Sta 1)							
Run 1				1	1	1	1
Run 2					1	1	1
Run 3					1	1	1
Run 4				1		1	1
Run 5					1	1	2
Run 6						1	2
Run 7						1	2
PT 5.3 SPS aborts (Sta 1)							
Run 1				1	1	2	2
Run 2					1	1	2
Run 3				1	1	1	2
Run 4					2	2	3
PT 5.4 Launch and ascent contingencies							
Run 1				1	1	2	3
Run 2					1	2	3
Run 3				1	1	2	3
Run 4					1	2	3
Run 5					1	2	3
Run 6					1	2	3
Run 7					1	2	3

the flight crew to typical mission situations with some emphasis on preliminary mission rules. The following milestones are associated with this type of training.

ATMM-1. Each astronaut, as a member of a flight crew, has been introduced to an all-go typical mission by participation in a non-real time typical mission. (The non-real time typical mission reduces those periods of low crew activity.)

ATMM-2. Each astronaut, as a member of a flight crew, is familiar with the normal functions associated with the family of missions (including trajectories) assigned to Block I, in addition to a few deviations in spacecraft position, velocity, and attitude. This does not require previous training with spacecraft system malfunctions.

ATMM-3. Each astronaut, as a member of a flight crew, has been introduced to a few typical missions including mission situations (deviations and spacecraft malfunctions).

ATMM-4. When each astronaut, as a member of a flight crew, is confronted with an abnormal mission situation, he is able to take action appropriate to the situation and its time of occurrence in the mission. This will involve several typical missions, including spacecraft malfunctions and deviations in spacecraft position, velocity, and flight path.

ATMM-5. When each astronaut, as a member of a flight crew, is confronted with an abnormal mission situation, he is able to take action appropriate to the situation and its time of occurrence in the mission. Each flight crew member is able to develop new, improved procedures based on his personal knowledge and ability. This involves some typical missions with a high density of spacecraft malfunctions and deviations in spacecraft position, velocity, and flight path. Training to accomplish this milestone would occur after all-go typical mission or all-go integrated typical mission training.

The Apollo Mission Simulator Utilization Plan, the subject of Paragraph 2.11, identifies training situations which would enable the flight crew to become familiar with typical mission situations.

2.8 INTEGRATED TYPICAL MISSION TRAINING

Integrated typical mission training brings the previously separate training of the flight crews and the flight controllers from MSCC into a combined training operation. The flight crew will improve procedures and cope with typical situations in working interface with the Manned Spacecraft Control Center. The following milestones are associated with this type of training.

AITM-1. Each flight crew has been introduced to an all-go integrated typical mission by participation in a combined training exercise involving MSCC personnel and a simulated MSFN.

AITM-2. Each flight crew is familiar with the normal MSCC/flight crew integrated functions associated with the possible family of missions for Block I. Non-real time missions are used to enable more practice on those functions which can best be accomplished in the integrated mode.

AITM-3. Each flight crew has been introduced to a few integrated typical missions, including a few mission situations (deviations and spacecraft malfunctions).

AITM-4. Each flight crew is familiar with the normal MSCC/flight crew integrated functions and with those integrated functions resulting from mission contingency situations that are associated with the family of possible Block I missions. Non-real-time missions are used to enable more practice on those functions which can best be accomplished in the integrated mode in accordance with existing mission rules.

AITM-5. Each flight crew is familiar with the normal MSCC/flight crew integrated functions and very familiar with those integrated functions resulting from two-thirds of all identified mission contingency situations that are associated with the family of possible Block I missions. Non-real time missions are used to enable more practice on those functions which can best be accomplished in the integrated mode in accordance with existing mission rules.

2.9 SPECIFIC MISSION TRAINING

Specific mission training for the flight crew will involve practice on procedures and with situations requiring decisions. This part of the training will be accomplished using the AMS. The following milestones are associated with this type of training.

ASMM-1. Each flight crew will have practiced the specific mission, including one-half of all identifiable mission contingency situations, to improve dependability and to ensure a reaction time well within acceptable limits. Each flight crew will also have accomplished sufficient training on new functions incorporated into the AMS as a result of recent spacecraft changes or a decision to increase the training capability of the AMS. Practice on the specific mission will be normally in non-real mission time to enable more emphasis on periods of high flight crew activity.

ASMM-2. Each flight crew will have practiced the specific mission, including all identifiable mission contingency situations, to improve dependability and to ensure a reaction time well within acceptable limits. Each flight crew will also have accomplished sufficient training on new functions incorporated into the AMS as a result of recent spacecraft changes or a decision to increase the training capability of the AMS. Most practice on the specific mission will be in non-real time to enable more emphasis on periods of high flight crew activity.

The AMS will be used to accomplish integrated specific mission training during this period of time. The following milestone is associated with this training.

AISM-1. The flight crew and backup will have practiced all required integrated action, including at least one final real-time specific mission involving MSCC and MSFN personnel in accordance with the current mission rules. This real-time mission should be divided into approximately 8-hour segments, each with several break periods, to reduce crew fatigue in the one-g environment.

During preflight test and checkout of the spacecraft the flight crew will be part of the checkout team. The crew members will participate in Engineering conferences and will observe, and take part in, the checkout procedures. Such participation, aside from developing confidence in the spacecraft, will pinpoint possible variations between simulator operation and operation of the assigned spacecraft. Test participation training milestones are discussed in Section 2.4 of this Training Plan.

2.10 APOLLO PART TASK TRAINER EXERCISE PLAN

S&ID prepared the APTT Exercise Plan for two purposes: to provide S&ID Apollo Engineering with a detailed definition of the ultimate purpose

and applications of the part task trainer and to provide detailed recommendations to NASA on trainer utilization.

The part task trainer contract was cancelled on November 6, 1964, by Supplemental Agreement 60. Although there is no longer a part task trainer in the Apollo program, there is still a requirement for the type of training originally identified to be accomplished on it. The part task exercises and the crew procedures exercises (identified in the Exercise Plan as Mission Segment Exercises) form the basis for the part task and crew procedures training discussed in Section 2.6 and Appendix B of this Plan. Appendix A to this Plan provides a synopsis of each exercise defined in the APTT Exercise Plan and a suggested order of training accomplishment.

In many cases the training identified in the APTT Exercise Plan and ultimately in the AMS Instructor Handbook requires a spacecraft system malfunction to initiate a specific flight crew action. Accordingly, S&ID Apollo Training prepared the plan for preparation of the catalogs of malfunctions to be used in the APTT and AMS, SID 64-913, dated April 1964. This plan was sent to NASA on 30 April 1964. Then, in accordance with SID 64-913, S&ID Apollo Training prepared the Apollo part task trainer malfunction selection catalog, dated 15 May 1964. In September 1964 the catalog was formalized as AMS and APTT Malfunction Catalog, SID 64-1638. This catalog was sent to NASA-FCSD in November 1964. The catalog is being currently revised. It will contain approximately 450 AMS malfunction data sheets, each one identifying a recommended simulated spacecraft malfunction. Appendix D to this plan contains two of these malfunction data sheets.

The scope, purpose and content of the APTT Exercise Plan was informally reviewed with MSC-FCSD on April 16, 1964. The revision used was that of March 17, 1964. No additional revisions are scheduled.

2.11 APOLLO MISSION SIMULATOR UTILIZATION PLAN

S&ID is presently preparing the Apollo Mission Simulator Utilization Plan for the same purposes as the Part Task Trainer Plan. These purposes are to provide S&ID Apollo Engineering with a detailed definition of the ultimate purposes and applications of the mission simulator and to develop a detailed recommendation to NASA on simulator utilization by S&ID.

The three sections of the AMS Utilization Plan are as follows:

Section I. Training (Trainer) Requirements
Section II. Syllabus for Flight Crew Training
Section III. Utilization Schedule

The training requirements section will include for each manned mission: (1) required normal functions and (2) a list of training situations, each one supported by a training situation data sheet for the non-integrated mode and integrated (MSCC-SCATS-AMS) mode. A training situation results when a simulated spacecraft deviation (position, velocity, and flight path) and/or a simulated spacecraft system malfunction are inserted into the simulated normal mission functions. The training situation is required to enable the flight crew to practice abort/continue decisions and related procedures for the normal and abnormal conditions associated with each manned mission. The training situation data sheet is the basis for Section I of the Utilization Plan. The data sheet is configured so that it functionally defines the situation for the S&ID Trainer Equipment Department (trainer performance characteristics), training syllabus activities, and the AMS instructor handbook activities.

The syllabus section will identify the manner in which the classroom activities, test participation activities, and AMS activities will be combined to define typical mission training (integrated and non-integrated mode) and specific mission training (integrated and non-integrated mode). To define the AMS activities in the syllabus, training session requirements will be identified. These requirements will include some sessions with only normal mission functions and other sessions involving one or more training situations.

The utilization schedule section will identify all periods of activity for the AMS. This includes flight crew training periods, FCD training periods, modification periods, and any other training related activities.

The AMS and APTT Malfunction Catalog, SID 64-1638, dated September 1964, provides a source of recommended simulated spacecraft malfunctions required to create training situations.

A preliminary AMS Utilization Plan, dated 2 September 1964, was published and provided to S&ID Apollo Trainer Engineering as preliminary trainer performance characteristics. This preliminary issue contained only a list of training situations for the planned-for manned missions 203A, 204A, 205A, and 506A. The Plan was updated and published on 30 October 1964. Copies of this updated plan were sent to NASA-FCSD on 10 November 1964.

During a meeting between S&ID Training and NASA-FCSD on 3 and 4 December 1964, S&ID Apollo Training provided to NASA a document containing many situation data sheets.

2.12 PLAN FOR APOLLO MISSION TRAINING

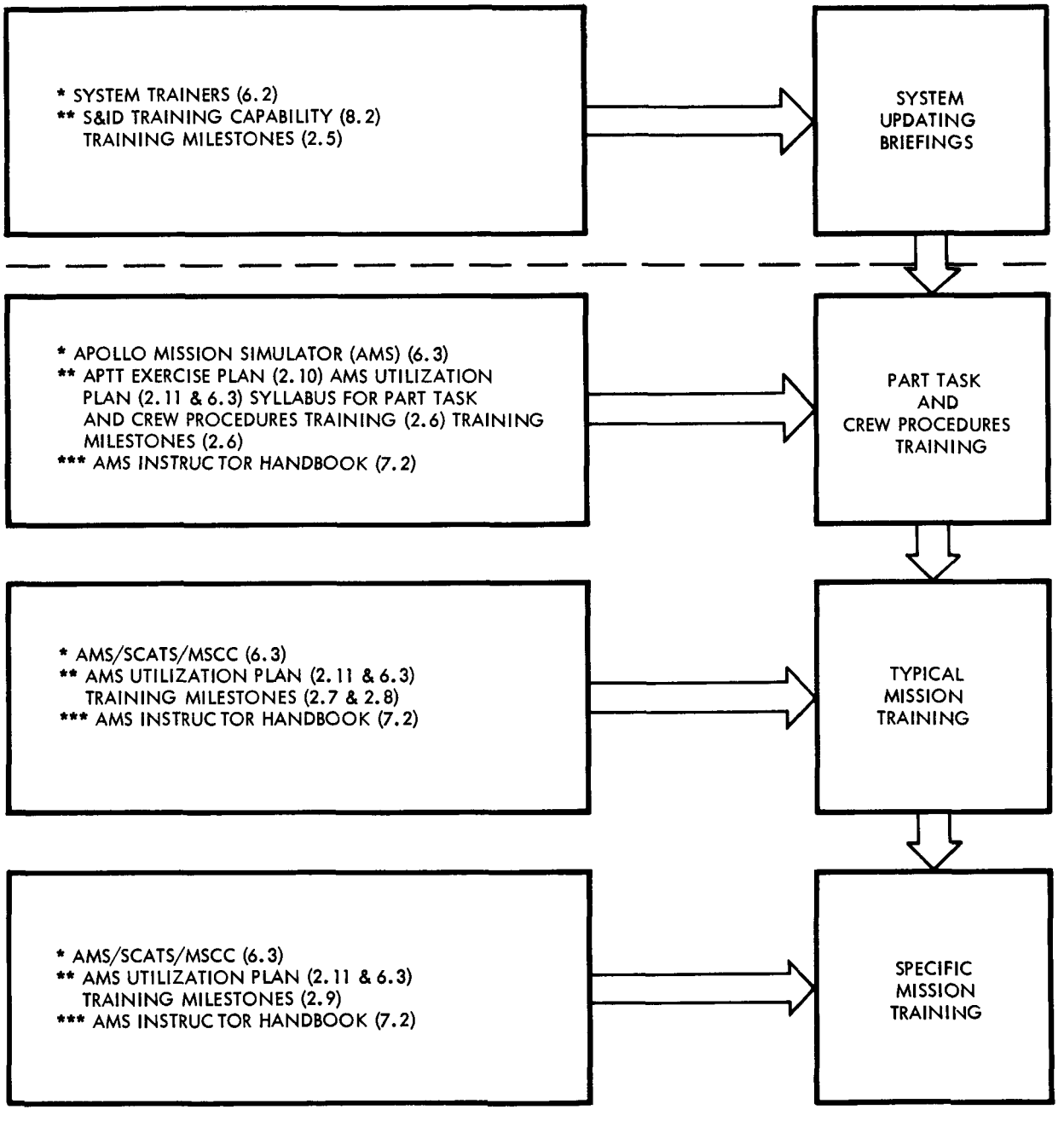
Figure 2-2 identifies the phases of flight crew mission training and the briefings required to bring each flight crew member to a common

starting point for his mission training. Figure 2-2 also identifies the support activities with reference to the related sections of this training plan. These support activities are listed under the same three categories for each phase of mission training. These categories are required training equipment, required training activity, and instructions on training use of delivered trainer.

Several alternate flight crew training methods have been partially defined to date. It is intended that these alternate plans will assist NASA in responding to possible changes in Apollo program requirements. These alternate training methods are defined in terms of training milestones and are depicted in Figures 2-3 through 2-7. The training milestones are defined under the paragraph heading for each type of training.

The training method recommended by S&ID Apollo Training as the most efficient from a training viewpoint is depicted in Figure 2-6 and includes the following milestones: ASSM-2, APTM-4, ACPM-4, ATMM-4, AITM-4, ASSM-1, and AISM-1. S&ID training is continuing to define required flight crew training and to make time estimates required for that training. The current time estimates are as follows:

ASSM-2:	180 hours/all Block I flight crews
APTM-4:	78 hours/flight crew member (maximum trainer time/flight crew member/training day is 1.5 hours. Fifty hours of classroom time are also required).
ACPM-4:	105 hours/each flight crew (maximum trainer time/ flight crew/training day is 4 hours).
ATMM-4:	120 hours/flight crew (maximum trainer time/day/ flight crew is 4 hours).
AITM-4:	120 hours/flight crew-MSCC combination (maximum trainer time/day/flight crew is 6 hours).
ASMM-1 and AISM-1:	18 weeks total elapsed time (practice on AMS to satisfy these training milestones is to be on a non-interference basis for accomplishment of the AENM-, ASCM-, and ATPM-milestones also required during this specific mission training period).



* REQUIRED TRAINING EQUIPMENT
** REQUIRED TRAINING ACTIVITY
*** INSTRUCTIONS ON TRAINING USE OF DELIVERED TRAINERS

Figure 2-2. Support Activities for Apollo Flight Crew Mission Training

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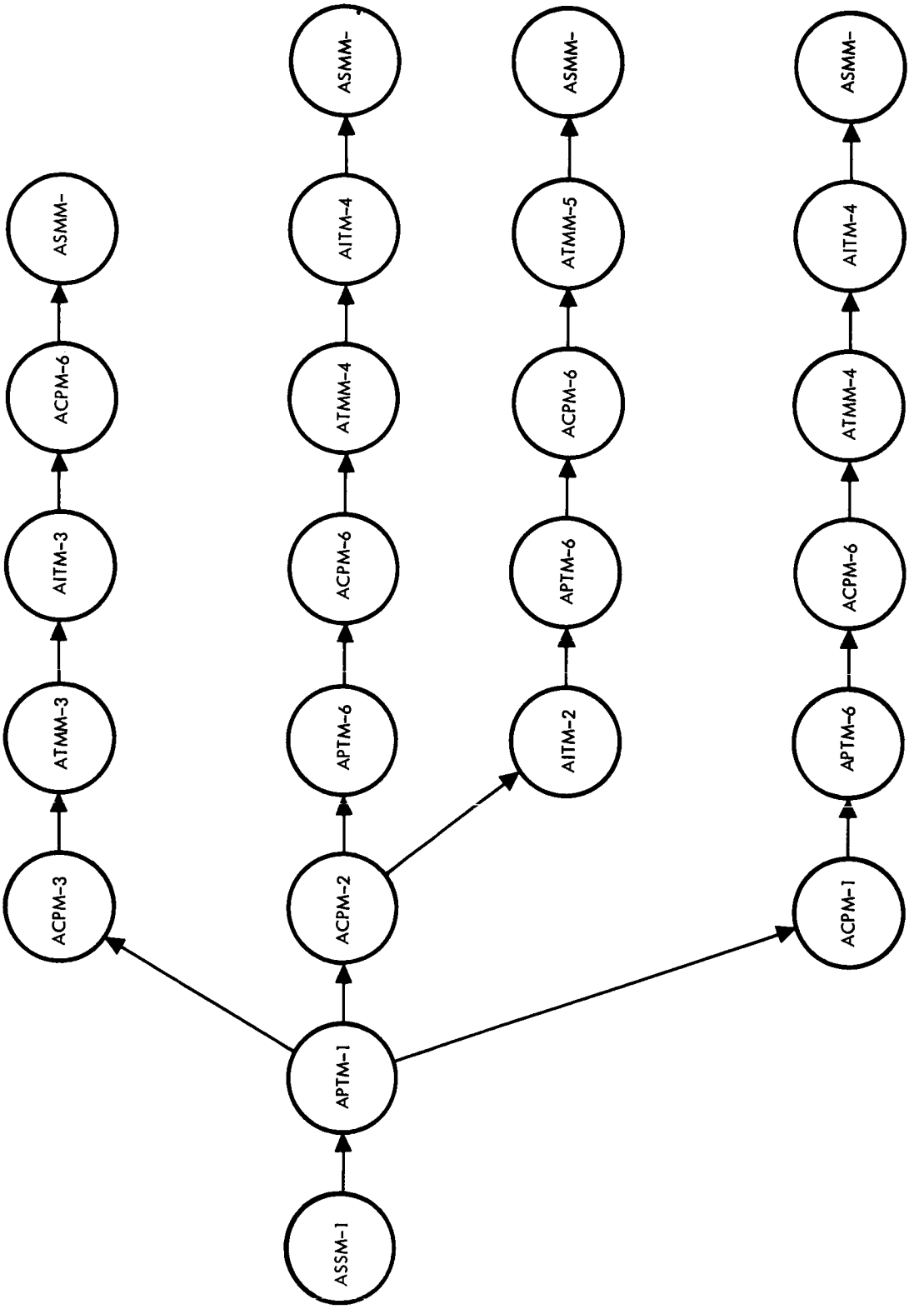

Figure 2-3. Alternate Flight Crew Training Method 1, With Variations

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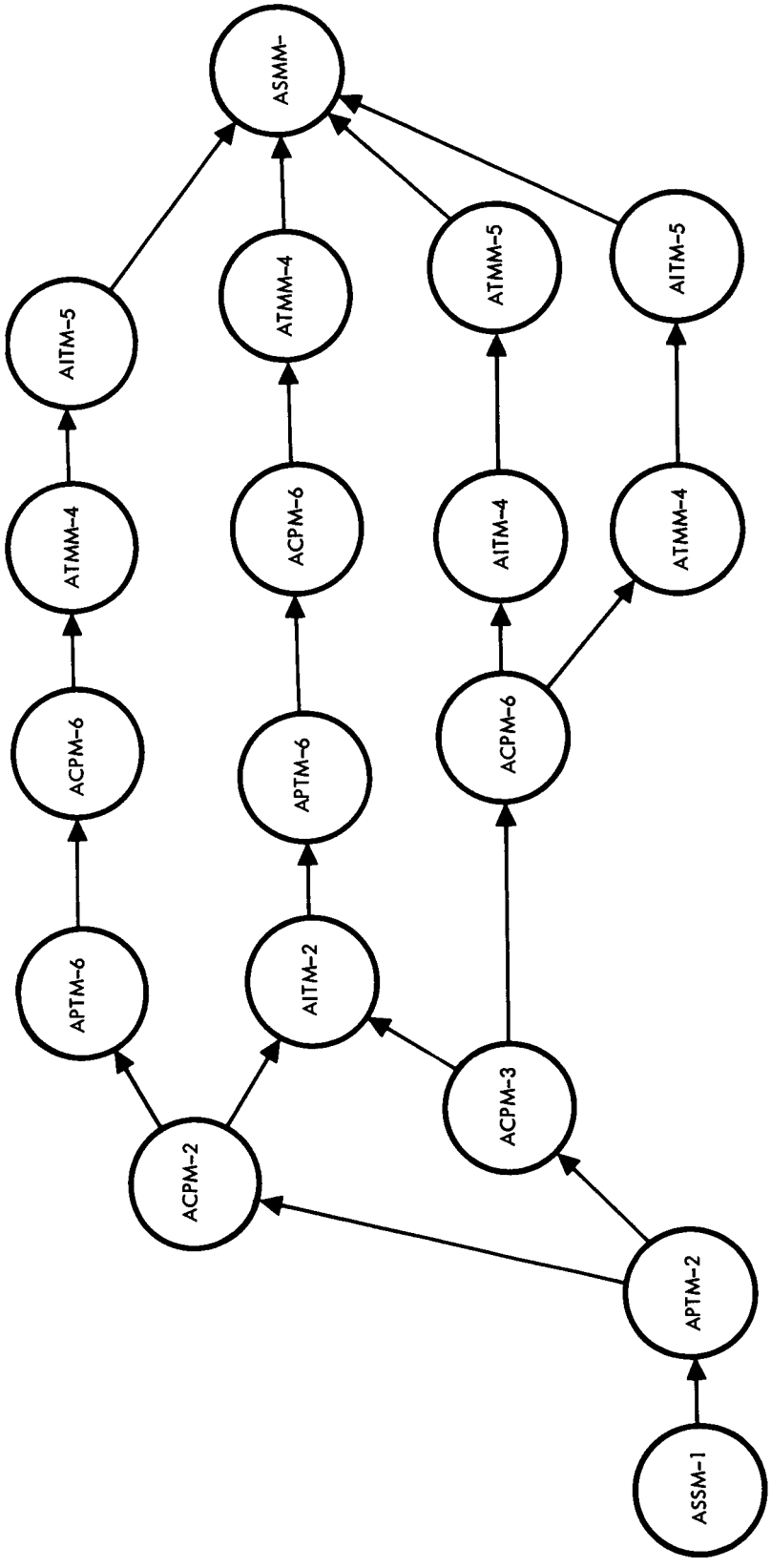

Figure 2-4. Alternate Flight Crew Training Method 2, With Variations

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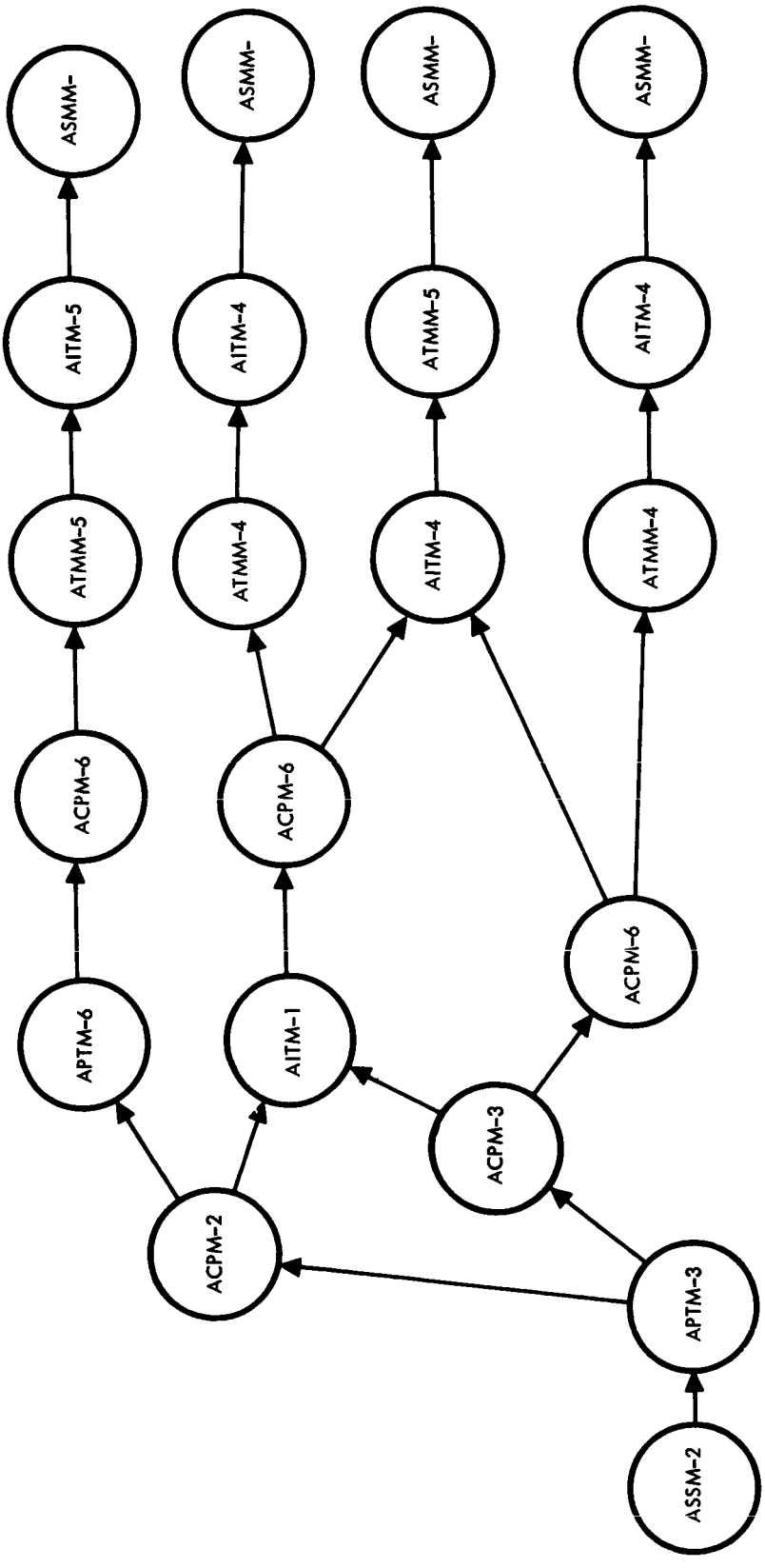

Figure 2-5. Alternate Flight Crew Training Method 3, With Variations

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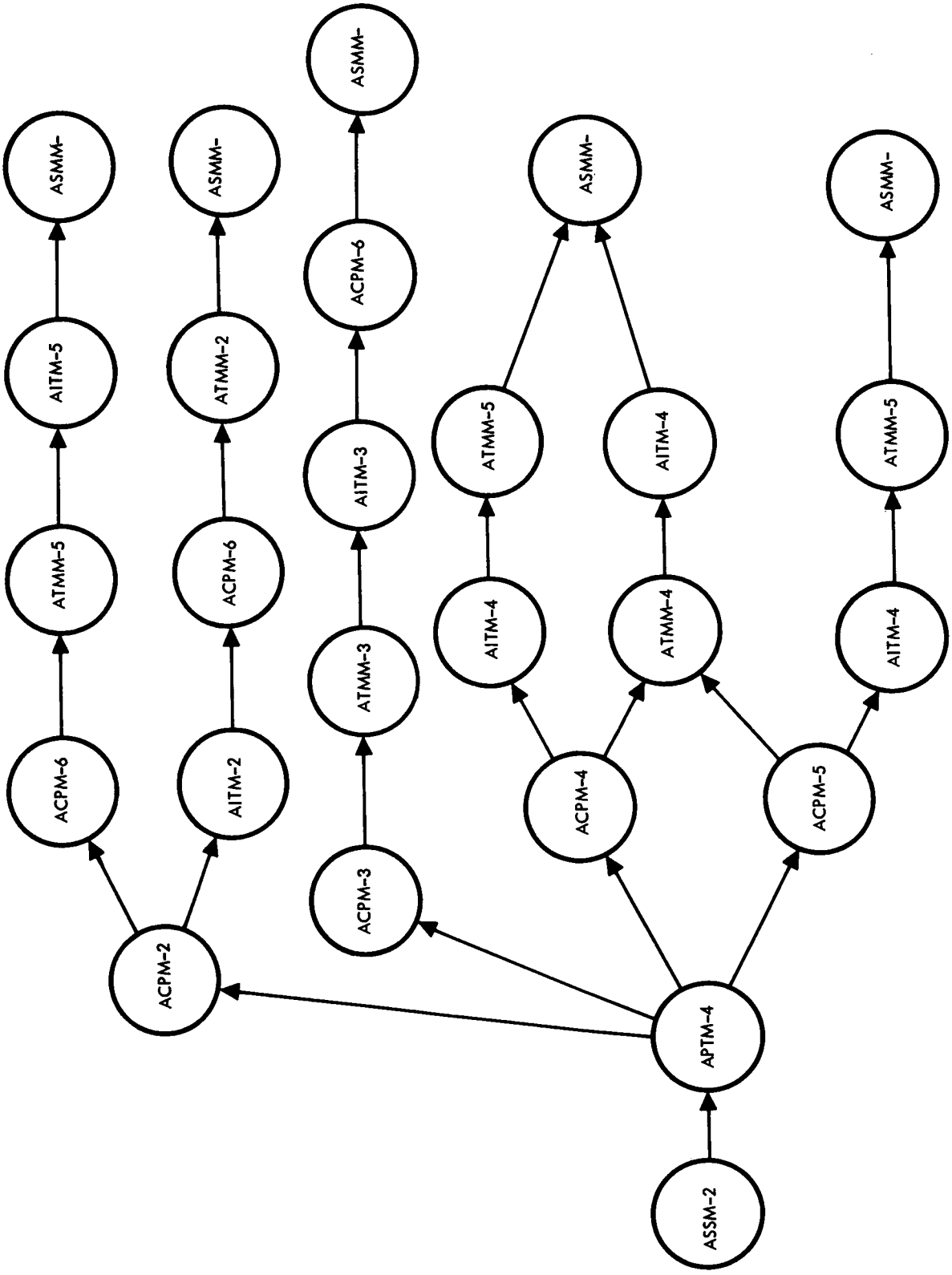

Figure 2-6. Alternate Flight Crew Training Method 4, With Variations

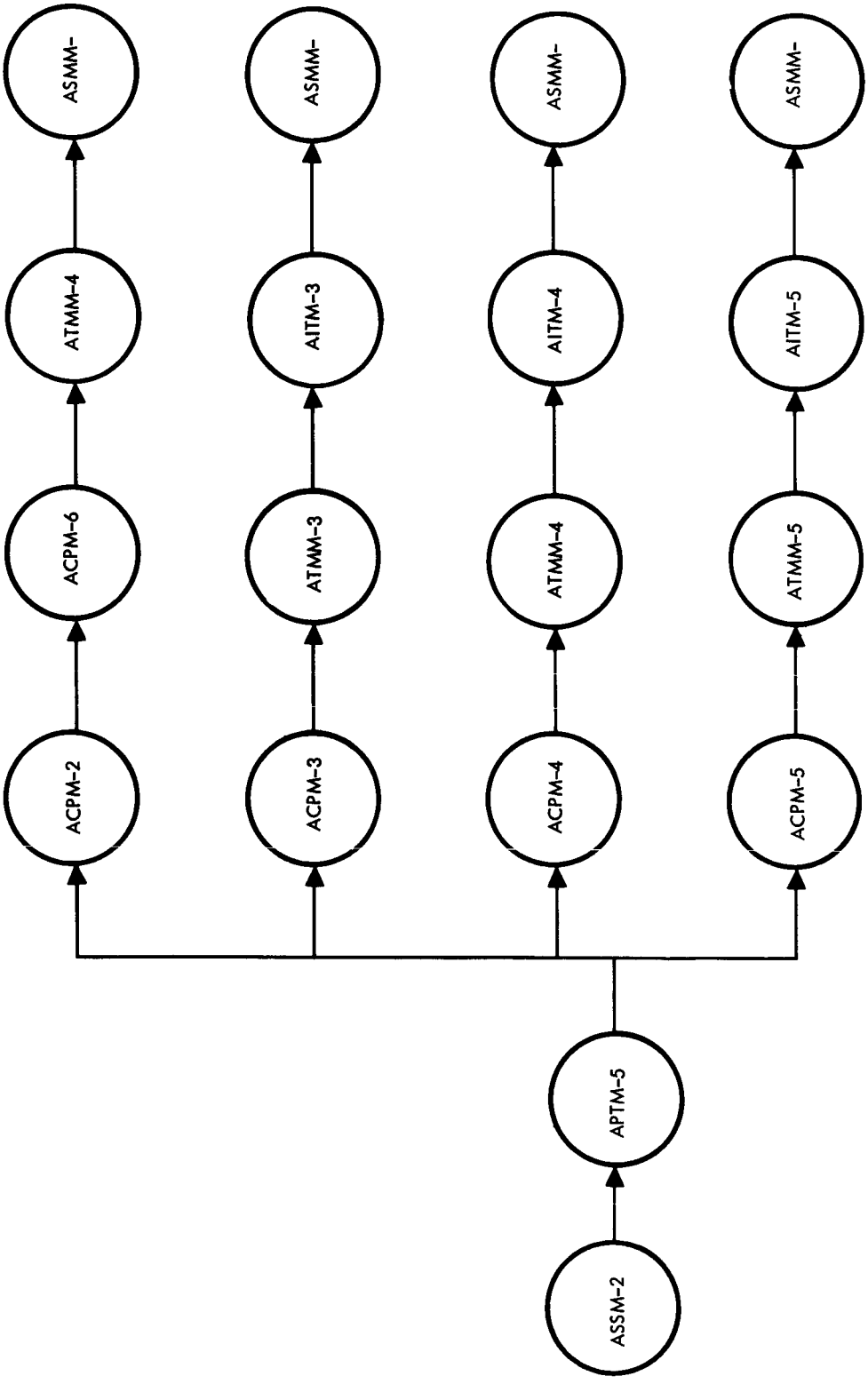

Figure 2-7. Alternate Flight Crew Training Method 5, With Variations

3.0 FLIGHT CONTROL DIVISION

3.1 MISSION CONTROL TEAMS AND SUPPORT STAFFS

Detailed Apollo training is required for mission control team and support staff personnel. This training will enable the personnel of these departments to participate effectively in the detailed technical planning of Apollo missions and also to monitor and analyze spacecraft data during and after flight.

3.2 OVERALL TRAINING REQUIREMENTS

Personnel of the Manned Spacecraft Control Center (MSCC) and remote sites will be trained in the following eight types (or phases) of training:

1. MSFN Systems Training - Training in the operation and utilization of MSCC and global network equipments

2. Booster Systems Training - Training in monitoring and analyzing the performance of the various Apollo booster configurations

3. Apollo Systems Training - A group of separately identified spacecraft systems courses incorporating the Apollo training essential to effective support of the Apollo mission

4. Open Loop Exercises - Training in specific tasks at specific work stations using portions of the MSCC-SCATS

5. Flight Controllers Crew Procedures Exercises - Training to familiarize flight controllers and selected support staff personnel with flight crew procedures

6. Integrated MSCC Exercises - Simulations of Apollo missions for integrated training of the control team; support staffs; global network personnel; and in selected cases, the flight crew (in the mission training simulator)

7. Specific Mission Exercises - Simulations of specific planned Apollo missions for integrated training of the control team; support staffs; the global network; and in selected cases, the flight crew

8. Lunar Excursion Module Systems Training - A group of training courses to provide that LEM training essential to effective support of the Apollo mission

The areas of FCD training that directly relate to S&ID involvement in the program are: Apollo systems training, flight controller APTT exercises, and those integrated mission exercises involving flight crew participation.

3.3 APOLLO SYSTEMS TRAINING

Figure 3-1 illustrates the manner in which the flight crew and flight controllers (augmented as required by support staffs) solve spacecraft systems problems as a coordinated joint effort. S&ID evaluates the spacecraft systems training requirements for flight controllers to be largely the same as for the flight crew. The basic difference is that the crew requires much greater practice in spacecraft procedures, while the flight controller requires greater capabilities in the area of system analysis.

S&ID recommends a series of Apollo spacecraft system courses for flight controllers. Recommended courses should include: detailed system theory of operation, MSFN and flight crew systems data, crew control capabilities, analysis of spacecraft data (voice, down-link, and tracking), requirements for and preparation of up-link data, and diagnosis and corrective action determinations for system contingencies. Training should involve the use of the Apollo system trainers.

Apollo spacecraft systems training courses recommended by S&ID for MSC-FCD are as follows:

Stabilization and Control System Training
Propulsion Systems Training
Telecommunications System Training
Guidance and Navigation System Training
Electrical Power Systems Training
Environmental Control System Training
Crew Systems Training
Structures and Mechanical Systems Training
Automatic Sequence Control System Training
Data Systems Training

3.4 FLIGHT CONTROLLER CREW PROCEDURES EXERCISES

To provide flight controllers and selected support staff personnel with a valid and comprehensive understanding of the crew compartment

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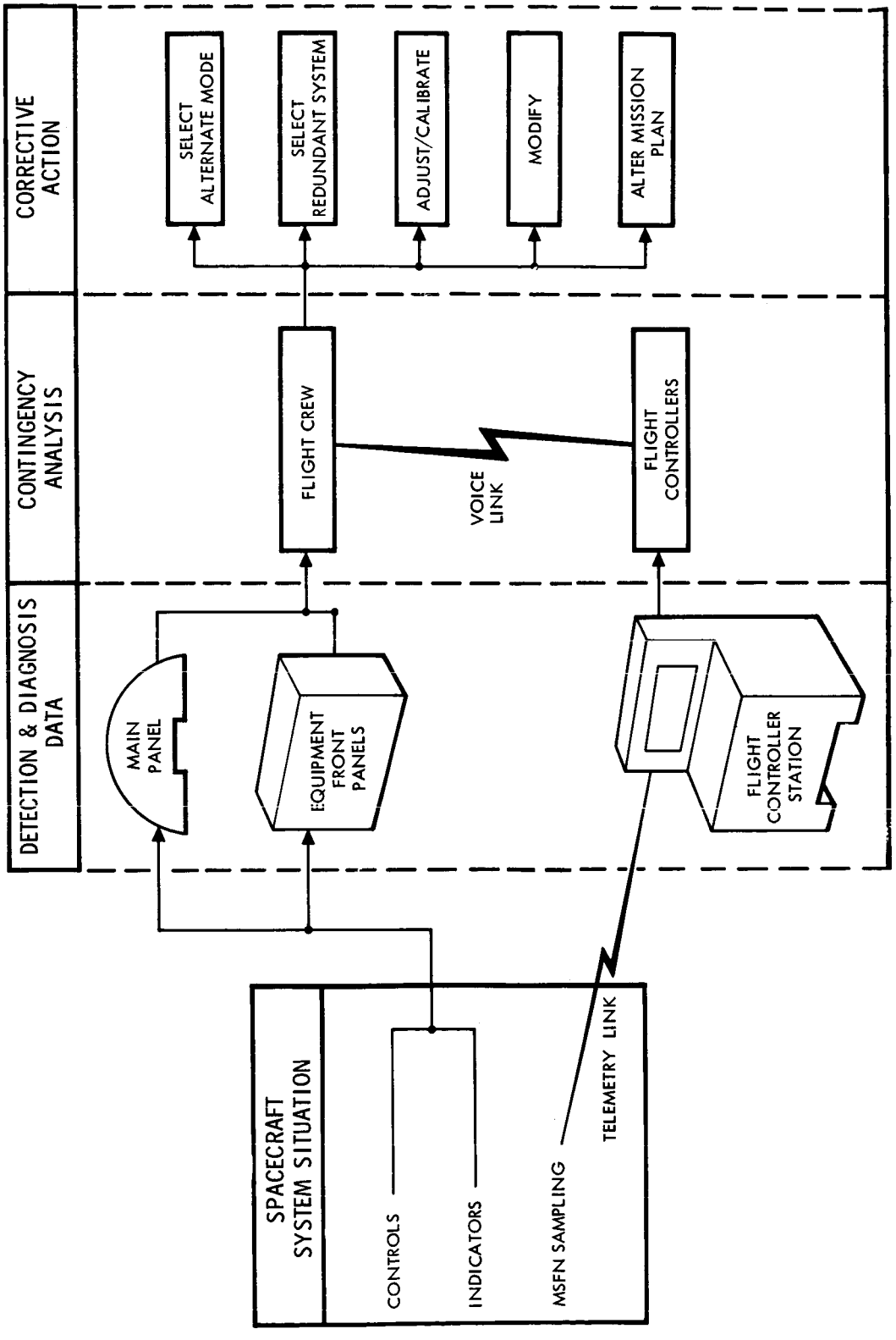

Figure 3-1. Apollo In-Flight Trouble Analysis

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environment and the flight crew capability, S&ID strongly recommends an abbreviated course in crew procedures for MSC-FCD.

3.5 MISSION SIMULATOR INTEGRATED EXERCISES

Paragraph 2.11 of this report discusses a utilization plan for the Apollo mission simulator. In this plan, S&ID intends to include recommedations for integrated exercises involving flight crew members.

3.6 OVERALL PROGRAM PLAN AND SCHEDULE

Figure 3-2 illustrates a very general suggested schedule for flight controller training. The basic purpose of the illustration is to provide a recommended phasing of Apollo systems, AMS training, and integrated exercises. The illustration is not intended to depict an overall schedule for FCD training.

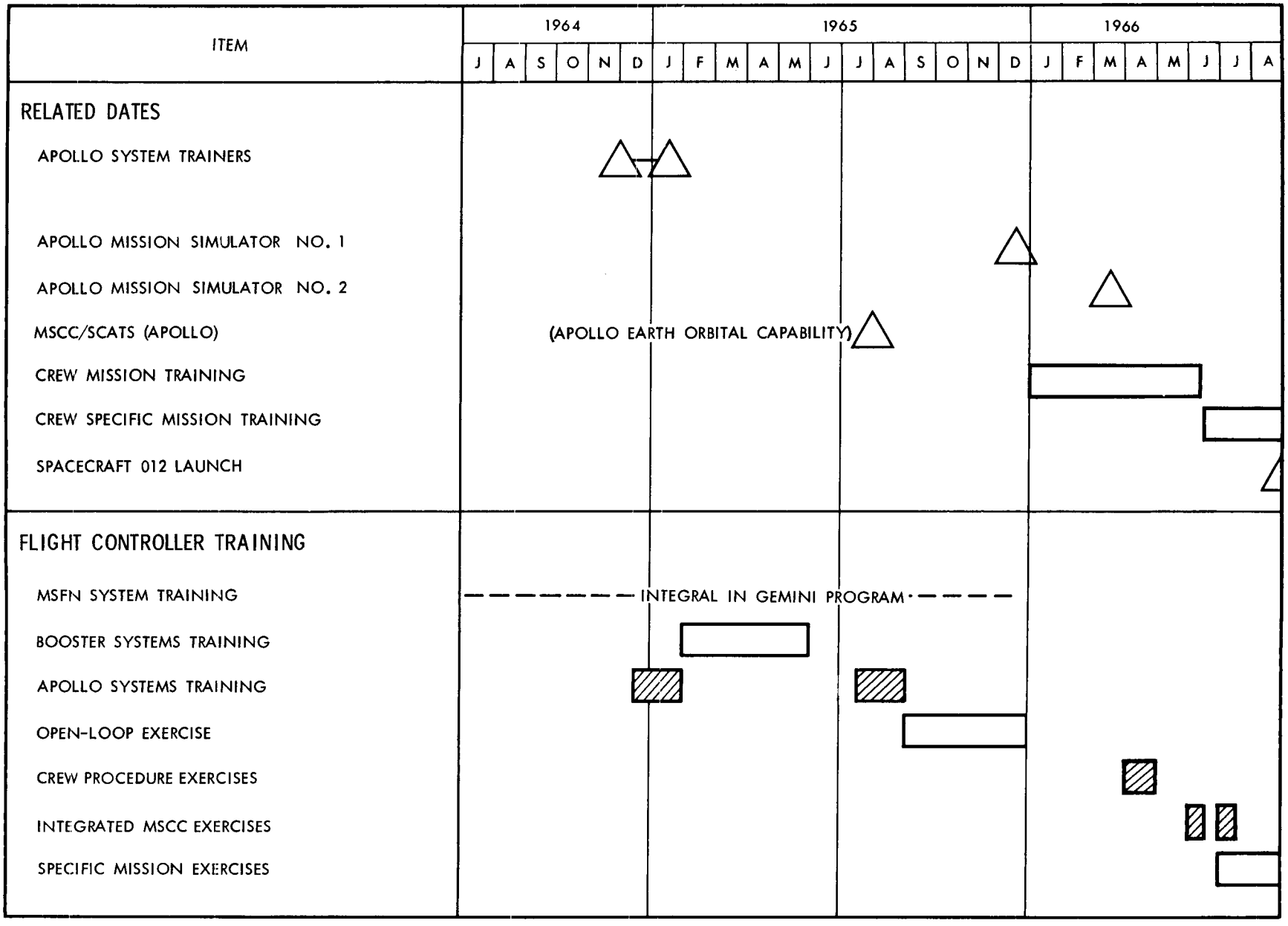

Figure 3-2. Suggested Phasing of Flight Controller Training

4.0 NASA-ETR AND MSC-WSMR

4.1 TRAINING REQUIREMENTS

Present planning for preflight testing, maintenance, and modification of Apollo boilerplates and spacecraft involves participation by both NASA and S&ID agenices. Although the scope of this training plan is intended to provide only NASA training data, the nature of NASA and S&ID joint participation is such that a statement of NASA training requirements also constitutes a statement of S&ID requirements. Detailed training requirements for each model of Apollo GSE are being documented on a GSE training requirement data sheet. Two of these data sheets are included in this plan as Appendix C. These data sheets are used to define recommended GSE training in detail and provide a focal point for the preparation of a GSE training capability by S&ID Apollo Training Services.

Training requirements research at S&ID indicates that five types of Apollo training are required in support of NASA-ETR and MSC-WSMR programs. These are familiarization system briefings, training in Apollo systems, a detailed briefing on automatic checkout equipment (ACE), a detailed briefing on bench maintenance equipment (BME), and Apollo cockpit test and checkout procedures.

4.2 TECHNICAL BRIEFINGS

Apollo familiarization and systems briefings for ETR and WSMR personnel have already been initiated by S&ID. A summary of the briefings accomplished at these two sites is provided in Table 4-1.

Apollo familiarization and systems briefings, provided by S&ID as requested, are arranged by the cognizant project officer at MSC-ASPO. Briefings recently requested by NASA-ETR started in November 1964 and are identified in Figure 4-1. The general content of these briefings is stated in Table 8-1.

4.3 APOLLO SYSTEMS TRAINING

S&ID recommends a series of detail briefings on Apollo systems for both ETR and WSMR. These recommended briefings will be for persons who are assigned system responsibilities on the ground checkout, maintenance, testing, and upkeep of Apollo boilerplates and airframes. They will be an extension of those briefings now being accomplished by S&ID at these two

Table 4-1. Apollo Technical Briefings at ETR and WSMR

Briefing	Date	Time (hr)	Students
ETR			
Electrical power system	26 Jan 1963	18	15
Apollo familiarization	2 Dec 1963	12	69
Launch escape system	10 Dec 1963	12	15
Electrical power system	17 Dec 1963	16	17
Spacecraft structures	19 Dec 1963	8	13
Apollo familiarization	13 Feb 1964	6	40
Apollo familiarization	17 Feb 1964	15	24
Communications and data	12 Apr 1964	12	13
Apollo program familiarization	2 Nov 1964	24	25
Apollo program familiarization	2 Nov 1964	24	24
Apollo spacecraft familiarization	12 Nov 1964	6	28
ACE familiarization	7 Dec 1964	8	9
ACE familiarization	7 Dec 1964	8	5
Structural and mechanical systems	8 Dec 1964	24	7
Electrical power system	15 Dec 1964	12	8
WSMR			
Apollo familiarization	17 Jun 1963	12	7
Apollo familiarization	20 Jun 1963	4	5
Propulsion	7 Oct 1963	40	11
Apollo familiarization	30 Oct 1963	20	14
Apollo spacecraft familiarization	7 Jul 1964	18	9
Propulsion	15 Jul 1964	12	16

sites. These briefings will include the following: spacecraft system information; a detailed description on the theory of operation and on the maintenance requirements of all related GSE in servicing, handling, and auxiliary equipment categories; the identification of the specific checkout and control functions performed on the spacecraft systems by BME, system test units (STU), acceptance and checkout equipment (ACE), and other checkout equipment.

Requirements for system training at ETR and WSMR differ considerably in contents and optimum dates of occurrence. The identification and scheduling of courses for each location are discussed separately.

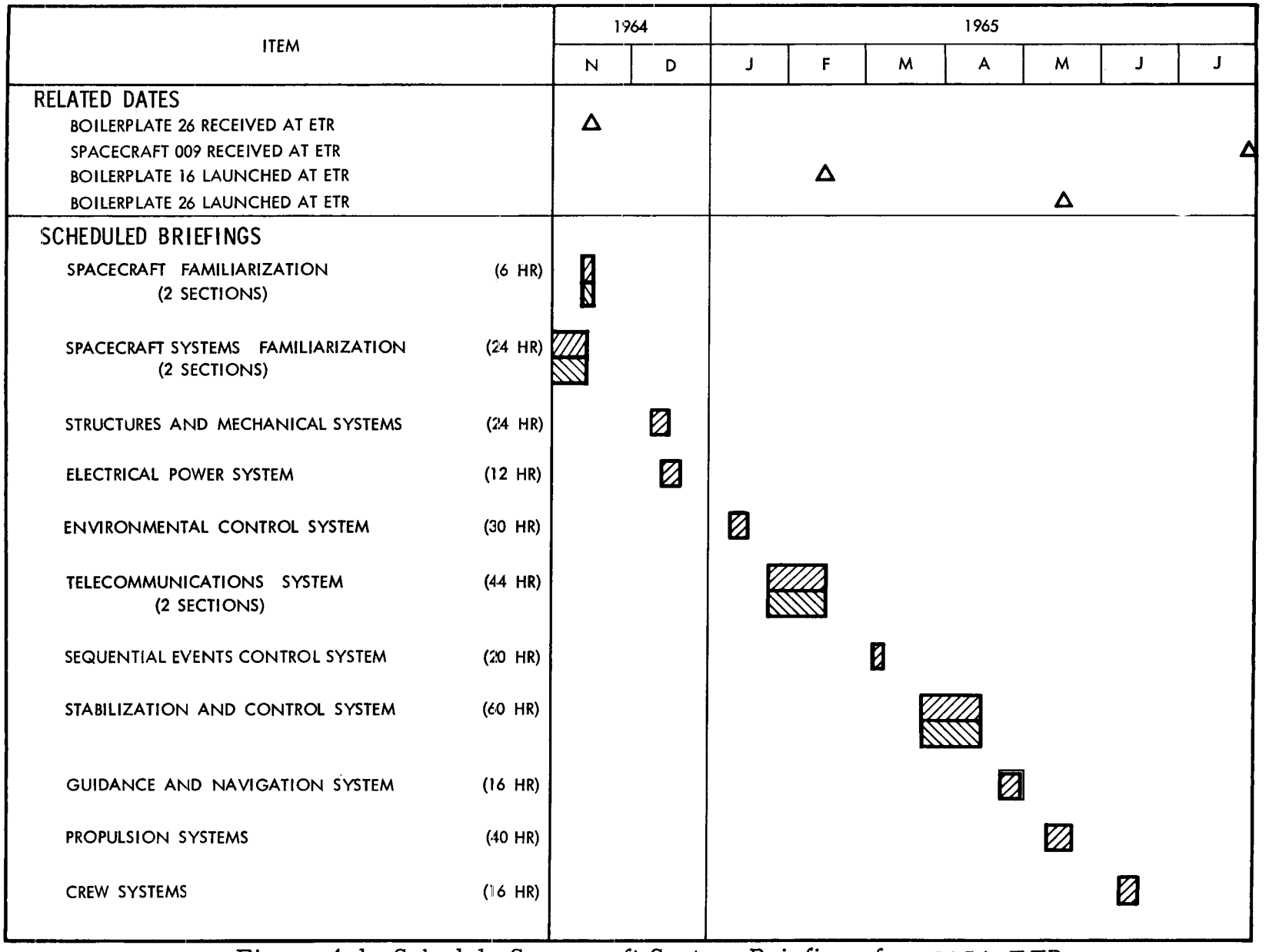

Figure 4-1. Schedule Spacecraft System Briefings for NASA-ETR

4.4 TRAINING ON THE AUTOMATIC CHECKOUT EQUIPMENT

S&ID recommends a detailed briefing for the operator and maintenance personnel of the automatic checkout equipment (ACE). This briefing would include a detailed description on the theory of operation and the maintenance requirements of this equipment. It would also include spacecraft system operation at a familiarization level.

4.5 TRAINING ON BENCH MAINTENANCE EQUIPMENT

S&ID recommends a detailed briefing for the maintenance personnel that will use Bench Maintenance Equipment (BME). This briefing would include a detailed description on the theory of operation and the maintenance requirements of BME, including the spacecraft instrumentation test equipment (SITE). This briefing would also include spacecraft system operation at a familiarization level.

4.6 COCKPIT TEST AND CHECKOUT TRAINING

A course in Apollo cockpit test and checkout procedures is required for NASA-ETR personnel who must participate in spacecraft test and checkout from within the command module. The course should include instruction in control and indicator functions, an introduction to in-flight procedures, and detailed training in test and checkout procedures.

4.7 OTHER SPECIAL PURPOSE BRIEFINGS

Special purpose briefings (functional type) would be provided using various portions of the briefings described in Sections 4.3 to 4.6 of this plan.

4.8 NASA-ETR TRAINING PROGRAM PLAN

Figure 4-2 presents a recommendation by S&ID for an overall Apollo training program at ETR. Course requirements are based upon boilerplate and airframe systems configurations. Scheduling information provides for course completion in the month preceding receipt of the boilerplate, airframe, or ground support equipment to which the training directly relates. Courses are identified as either initial training or updating briefings. Initial training is described in Paragraphs 4.3, 4.4, 4.5, 4.6, and 4.7. Updating briefings are recommended for systems that recur on subsequent boilerplates and airframes.

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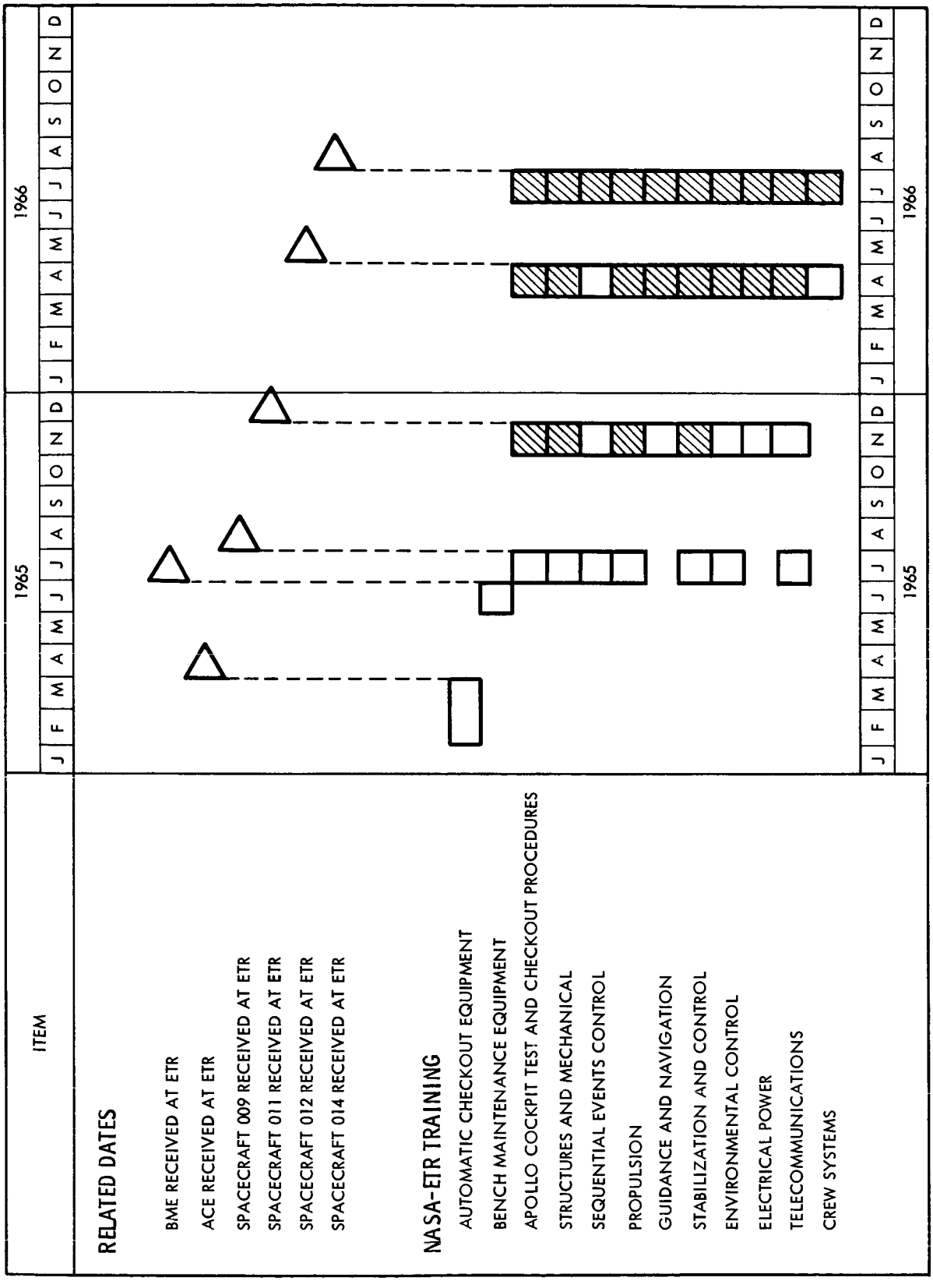

Figure 4-2. Training Requirements Schedule for NASA-ETR

4.9 WSMR TRAINING PROGRAM PLAN

Figure 4-3 presents a recommendation by S&ID for an overall Apollo training program at WSMR. The WSMR plan is prepared in the same manner as the plan for NASA-ETR (see Paragraph 4.8).

4.10 TECHNICIAN PERFORMANCE RELIABILITY

Training programs designed to ensure reliable technician performance are described in the S&ID Training Plan (see Section 8.5).

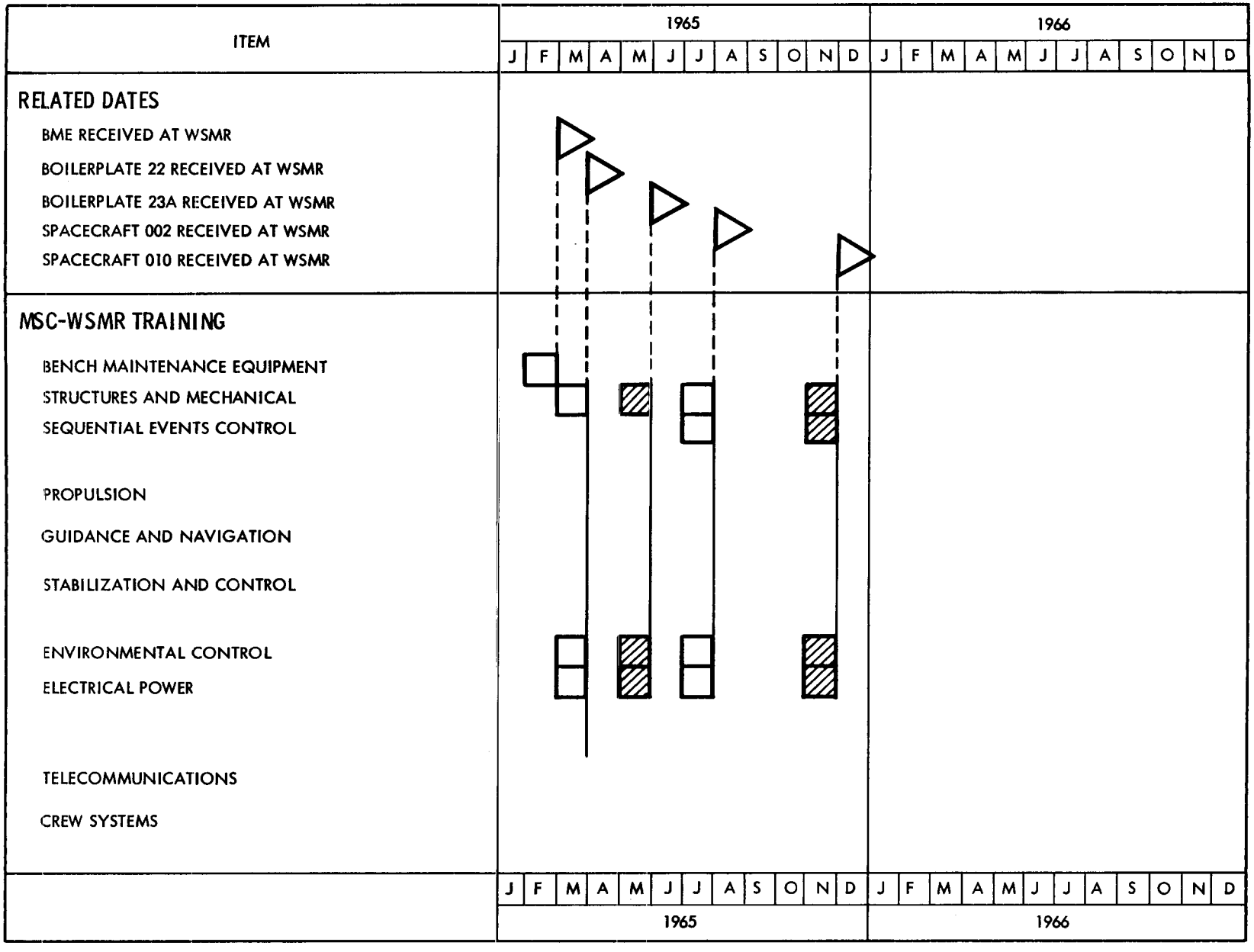

Figure 4-3. Training Requirements Schedule for MSC-WSMR

5.0 OTHER NASA TRAINING

5.1 APOLLO TRAINING FOR NASA HEADQUARTERS

During December 1963, S&ID provided technical training briefings on Apollo familiarization and on Apollo propulsion systems at NASA headquarters in Washington, D. C. S&ID recommends a series of short Apollo system briefings to acquaint personnel with program developments.

5.2 ASSOCIATE CONTRACTOR TRAINING

Technical briefings on Apollo systems can be efficiently utilized to train associate contractor personnel on the spacecraft system interfaces. S&ID has provided training in the Apollo stabilization and control system at AC Sparkplug and MIT and in the automatic checkout equipment for GAEC, AC Sparkplug, and MIT.

The training planned for GAEC personnel on common use GSE is the subject of Section 8.4 of this plan and of SID 64-1690.

5.3 SYSTEM TRAINING FOR SPACECRAFT 008

Master Development Schedule 8, Revision 1, identifies Apollo Spacecraft 008 as the spacecraft for environmental proof, to be delivered to the MSC space environmental facility during August 1965. It will be completely operable, except for the launch escape tower and live pyrotechnics. It will be supported with an extensive inventory of ground support equipment.

The training required for NASA to test, maintain, and modify spacecraft systems of Spacecraft 008 will be similar to that required by MSC-FO for Spacecraft 009, 011, and 012. Training recommended by S&ID in support of Spacecraft 008 includes: familiarization and systems briefings, Apollo systems training, and cockpit test and checkout training.

The nature and scope of Apollo training in systems and cockpit test and checkout are discussed in Paragraphs 4.3 and 4.6, respectively. S&ID recommends that training for Spacecraft 008 be accomplished in the third quarter of 1965. Courses recommended are the following:

Spacecraft 008 Cockpit Test and Checkout
Stabilization and Control System

Spacecraft 008 Propulsion System
Telecommunications System
Electrical Power System
Guidance and Navigation System
Environmental Control System
Spacecraft 008 Structures and Mechanical System
Crew Systems
Automatic Sequence Control System

C[redacted]

6.0 APOLLO TRAINING EQUIPMENT

6.1 TRAINING EQUIPMENT

Apollo training equipment consists of three types of trainers and associated equipment. When developed, the trainers are to be delivered as follows:

1. One set of systems trainers to MSC
2. One Apollo mission simulator to MSC
3. One Apollo mission simulator to ETR

A suggested trainer utilization plan is shown in Figure 6-1. These dates are from the requirements identified in other sections of this training plan, the scheduled shipping date for the trainers, and the planned time required for installation and checkout on site.

6.2 SYSTEM TRAINERS

The Apollo system trainers will be used to instruct Apollo personnel in system theory of operation, control and indicator functions, alternate modes and redundant systems, and trouble diagnosis philosophy. The Apollo system trainers consist of four system display trainers and a sequential flow trainer. These are:

1. Stabilization and control system trainer
2. Electrical power system trainer
3. Environmental control system trainer
4. Propulsion system trainer
5. Sequential flow trainer

Each system display trainer depicts system functional flow using the block diagram technique and consists of a mechanized, lighted-line representation of an Apollo spacecraft system; the controls and displays associated with each system; a special-signal panel; and a malfunction insertion panel. Each system display trainer is fully operational alone.

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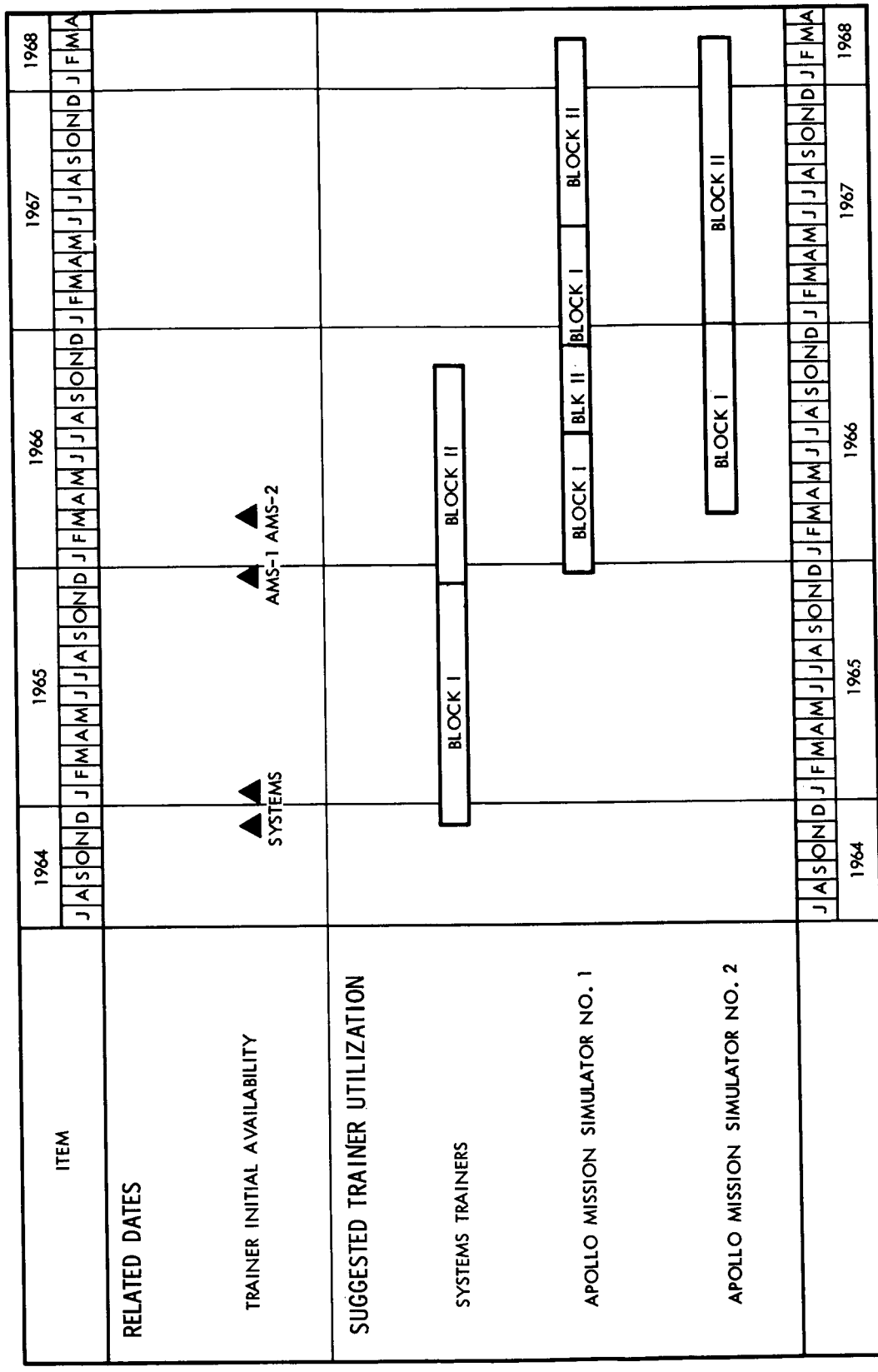

Figure 6-1. Suggested Trainer Utilization

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The sequential flow trainer displays (in schematic form) the power set, sequential events, and squib-end results for the launch escape, earth landing, and crew safety systems. The trainer displays (in functional block form) the EDS and output signals to other systems. Different color lines are used for different systems. The capability for malfunction of components is included on the control panel.

6.3 APOLLO PART TASK TRAINER

The Apollo part task trainer contract was cancelled on November 6, 1964, by Supplemental Agreement 60. The type of training previously recommended and planned for the Apollo part task trainer must now be accomplished using the Apollo mission simulator.

6.4 APOLLO MISSION SIMULATOR

The Apollo mission simulator (AMS) depicted in Figure 6-2 will be used to provide flight crew training in all types of the mission training described in Section 2.0. The following description of the AMS is aligned to an ultimate capability and not to the initially delivered configuration. The AMS is required for operation either with or without the interface for the Manned Spacecraft Control Center - Simulation Checkout and Training System (MSCC-SCATS) and the LEM mission simulator (LMS). When the AMS is operated independently of these items, their simulation is accomplished from the instructor console.

The interior crew compartment of the simulated command module is an authentic replica of the spacecraft command module in respect to size, shape, and internal equipment configuration. The controls and displays are representative of those in the spacecraft control panel with an appropriate indication on the instructor console.

The instructor operator station (IOS) provides the instructors with the means to control the simulator, monitor the performance of the trainees, and provide the necessary cues for crew decision training. It is a U-shaped construction designed to accommodate three instructors. The IOS console is slope faced for ease of reach and contains repeater displays of the instruments within the simulated command module, controls for directing training progress, and controls for the trainer associated and peripheral equipment.

Visual simulation equipment, supplied as an integral portion of the AMS, provides realistic scenes for observation through the side and docking windows and through the optical instruments of the simulated G&N system. In addition, LEM image generation for the rendezvous, transition, and docking maneuvers is provided.

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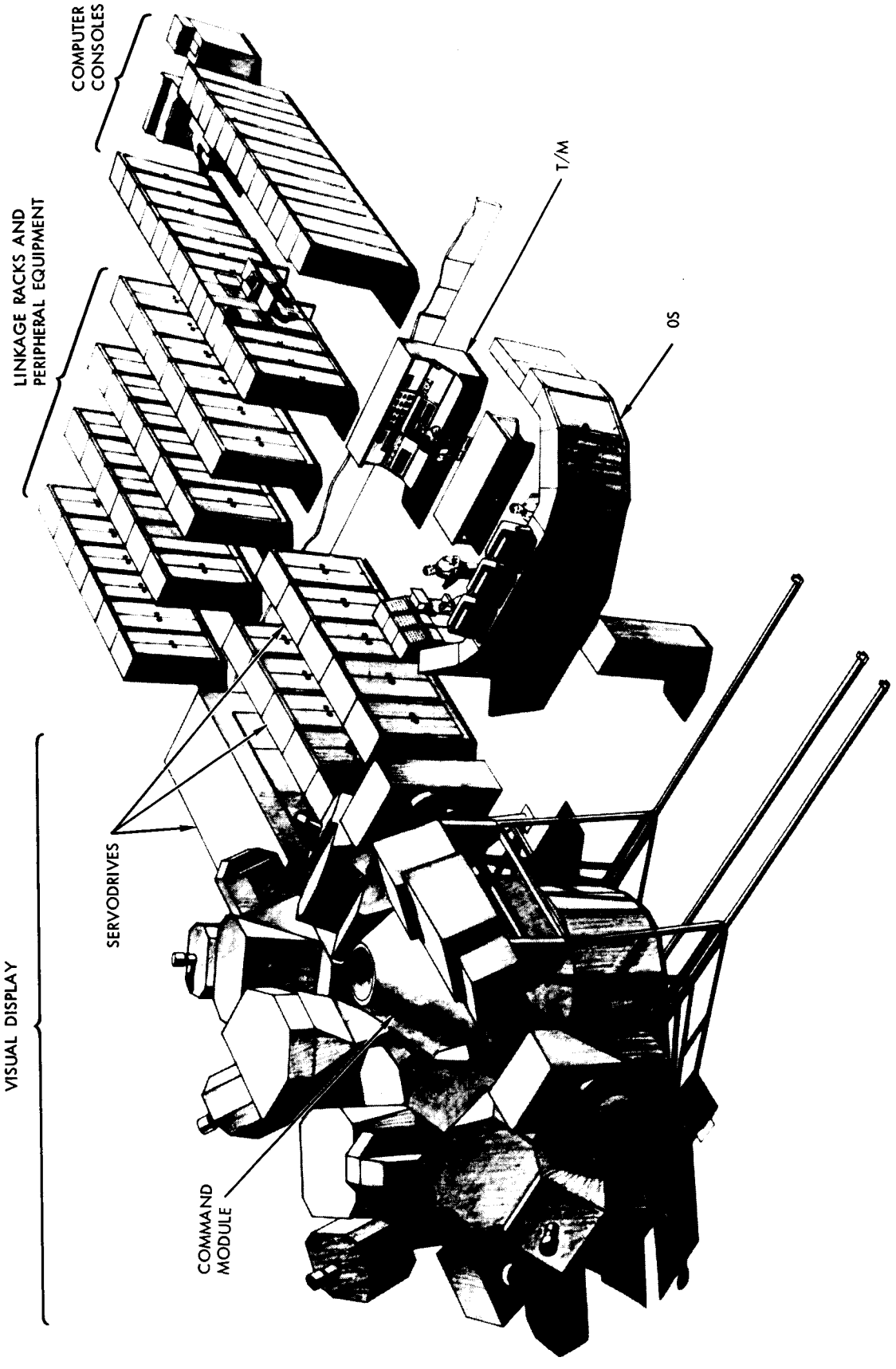

Figure 6-2. Artist's Conception of Apollo Mission Simulator

Aural simulation will be provided to produce realistic sound effects that are representative of rocket engines, reaction jets, and other related noises necessary to provide positive crew training. Both aural and visual simulation is coordinated with real time computer programming to maintain the correct relationship between mission events, the field of view, the line-of-sight angular displacement, and observable portions of the visual display. The instructor may override the computer control of the effects of the aural simulation equipment.

Integration of the AMS into exercises in working interface with the MSCC is accomplished with the SCATS. The integrated mode provides coordinated training for MSCC mission control teams, support staffs, and remote site flight controllers. The integrated mode of AMS utilization can be accomplished with either the MSC or the ETR simulator. A simplified block diagram of the MSCC-SCATS-AMS interface is shown in Figure 6-3. This figure illustrates that the MSFN network is used to interface the ETR simulator and the MSCC.

The AMS includes a telemetry console to be used in coordinating flight crew and flight controller training in the integrated mode. The console provides control of the simulated telemetry interface and is able to fault down-link channels.

The AMS is required to interface with the LEM mission simulator and the MSCC during AMS-LMS-MSCC operations. This capability will provide integrated task training of the flight crew for lunar orbital and rendezvous functions. The generation of a mission profile will be a joint function of the AMS and LMS training complexes. The MSCC will provide the trajectory information until S-IVB separation. A LMS-AMS integrated mode is presently being defined.

Figure 6-4 is a suggested utilization schedule for the Apollo mission simulators. The modification installation periods are planned to support the flight crew training that follows each modification. Each simulator has been considered separately for only that training that is to be accomplished on that simulator. The identified modifications represent planning information from a training viewpoint only. These are listed in gross terms, as follows:

1. AMS-1 Modification 1. This modification is required to change the initially delivered configuration and capability so that it reflects a Block I manned spacecraft and is capable of simulating a Block I manned mission.

2. AMS-2 Modification 1. Same as Modification 1 for AMS-1.

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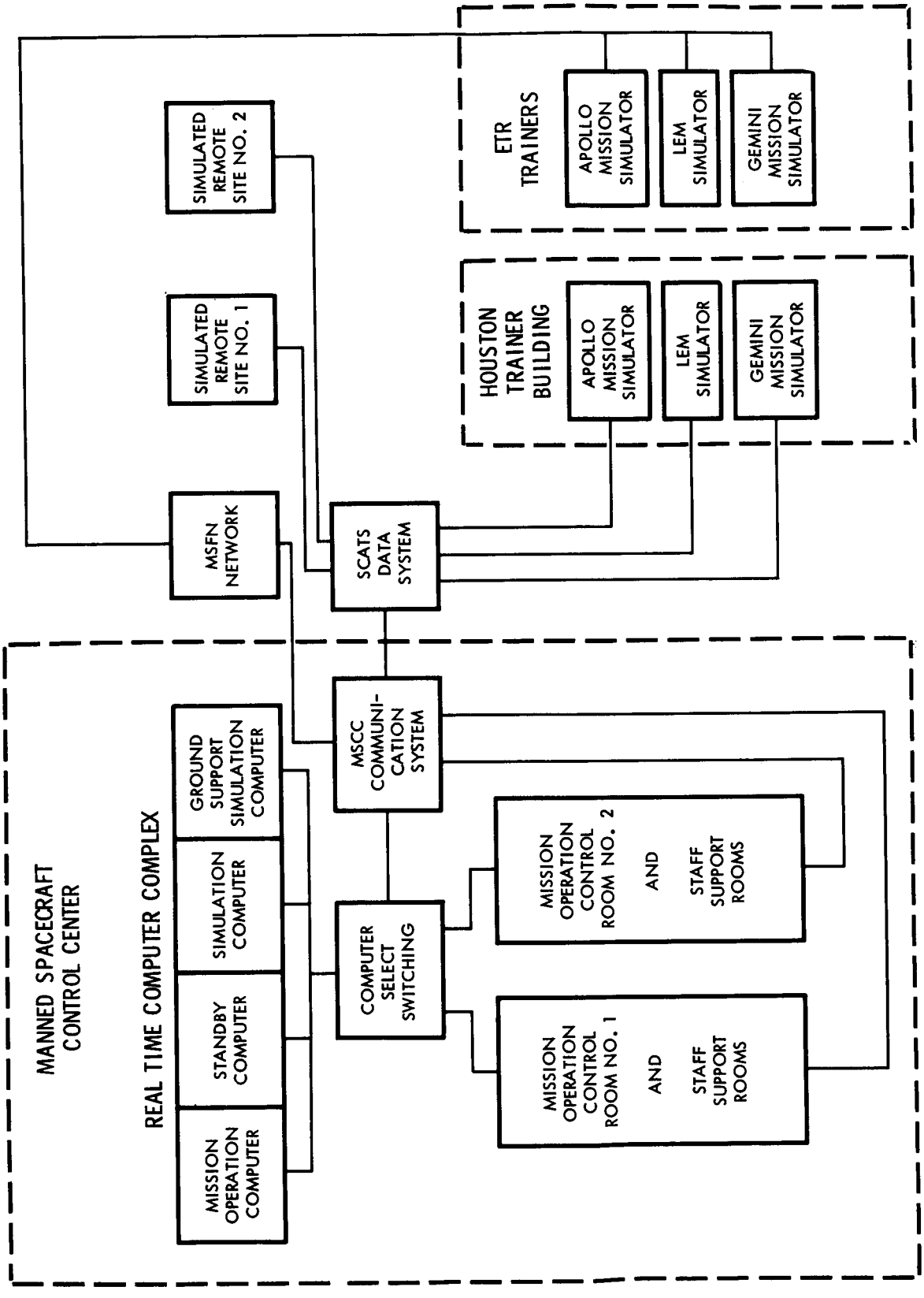

Figure 6-3. AMS-SCATS-MSCC Interface

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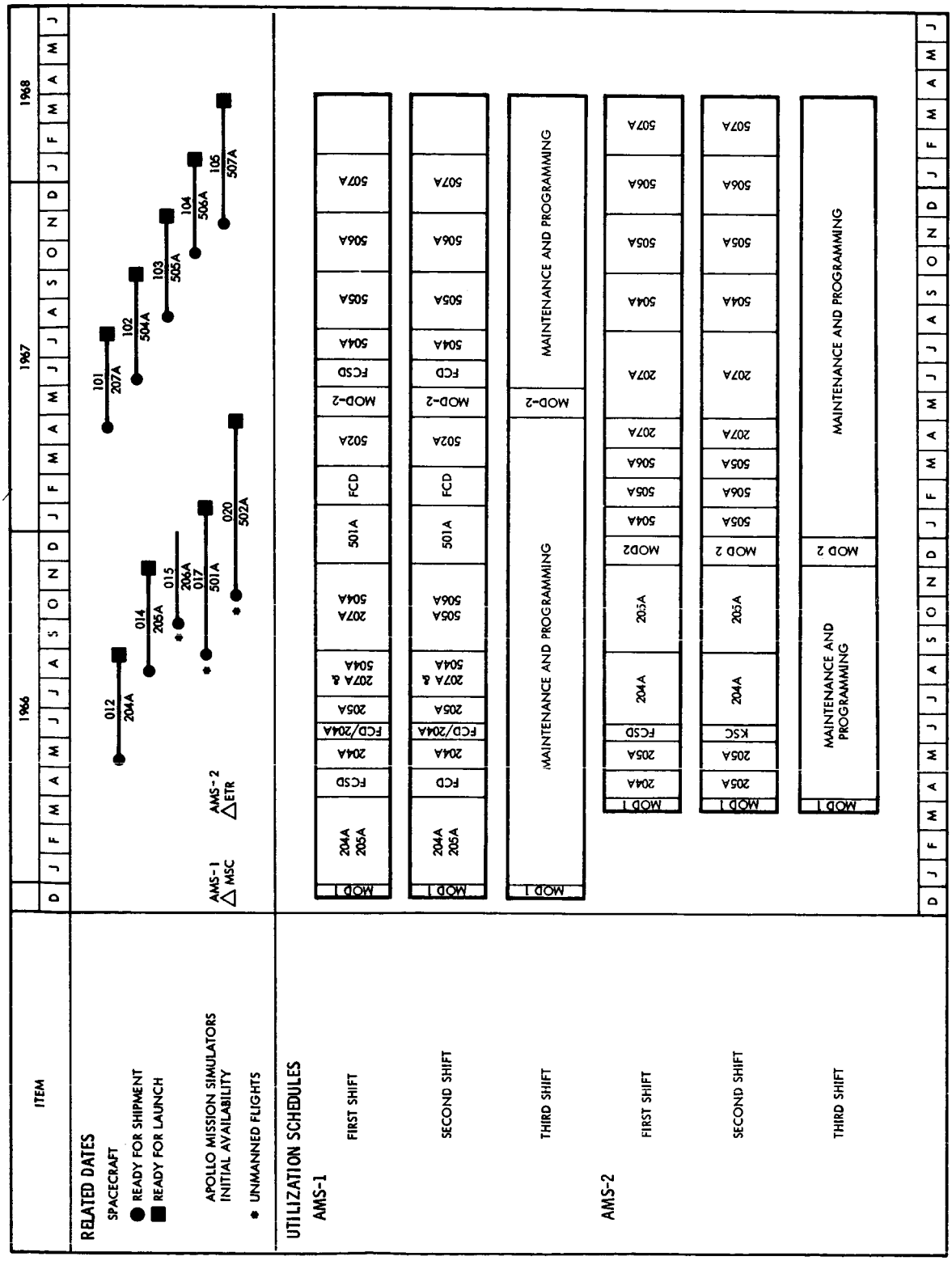

Figure 6-4. AMS Utilization Schedule

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3. AMS-1 Modification 2. This is to modify the simulator to reflect a Block II manned spacecraft and to increase its simulation capability to include a defined Block II mission.

4. AMS-2 Modification 2. Same as Modification 2 for AMS-1.

Additional modification will most likely be required. However, these modifications will be identified as required, following the basic ground rule for AMS capability that the AMS must be functionally exactly like the spacecraft for a given mission.

7.0 TRAINING DOCUMENTATION

7.1 TRAINING PLAN

This Training Plan and its revisions comprise one form of training documentation provided to NASA by S&ID. Contractual authorization of the plan is defined in the Foreword. Purpose, scope, and contents are discussed in Section 1.0.

7.2 TRAINER INSTRUCTOR HANDBOOK

S&ID will provide a trainer handbook that supports NASA conducted training associated with the Apollo mission simulator. The purpose of this handbook is to provide detailed instructions for using the Apollo mission simulator to train flight crew personnel. The handbook is comprised of two volumes. Volume I contains a functional and physical description of the simulator, procedures for instructor operation of the simulator, and a recommended syllabus of training sessions. Volume II contains instructor reference materials that are used to make up a complete instructor-operator data package for the accomplishment of each training session in the recommended syllabus. Table 7-1 identifies the section titles for Volume I and for Volume II.

Table 7-1. AMS Instructor Handbook Section Titles

Section	Volume I	Volume II
1	Description	Session Data
2	Operation	Training Task Data
3	Syllabi	
4	Computer Programs	
5	Training Tasks	
6	System Simulation	

Volume II is bound in such a manner that material may be removed for copying, as depicted in Figure 7-1. Figure 7-2 identifies the function of the trainer instructor handbook relative to other procedures and references

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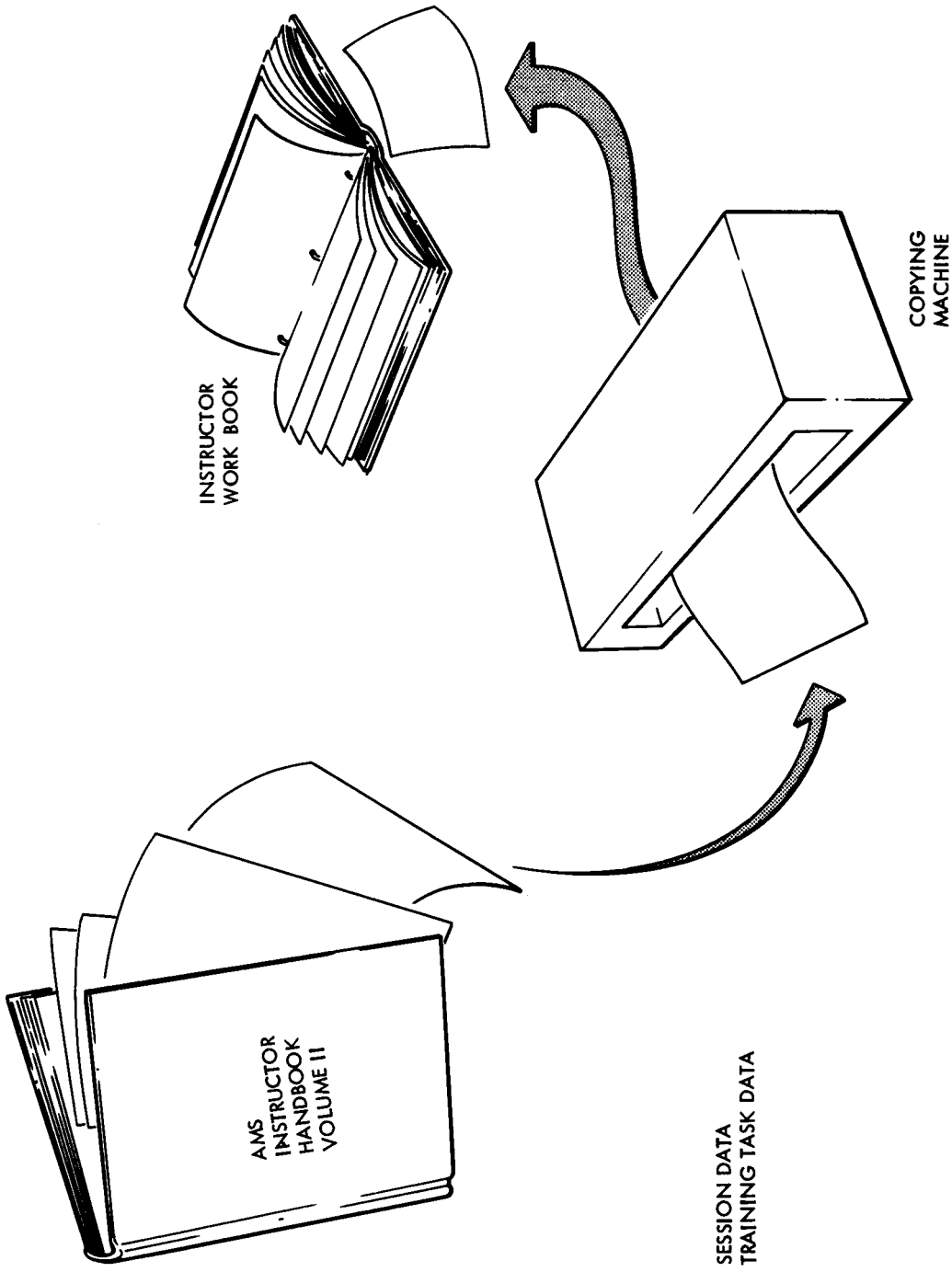

Figure 7-1. Trainer Training Session Preparation

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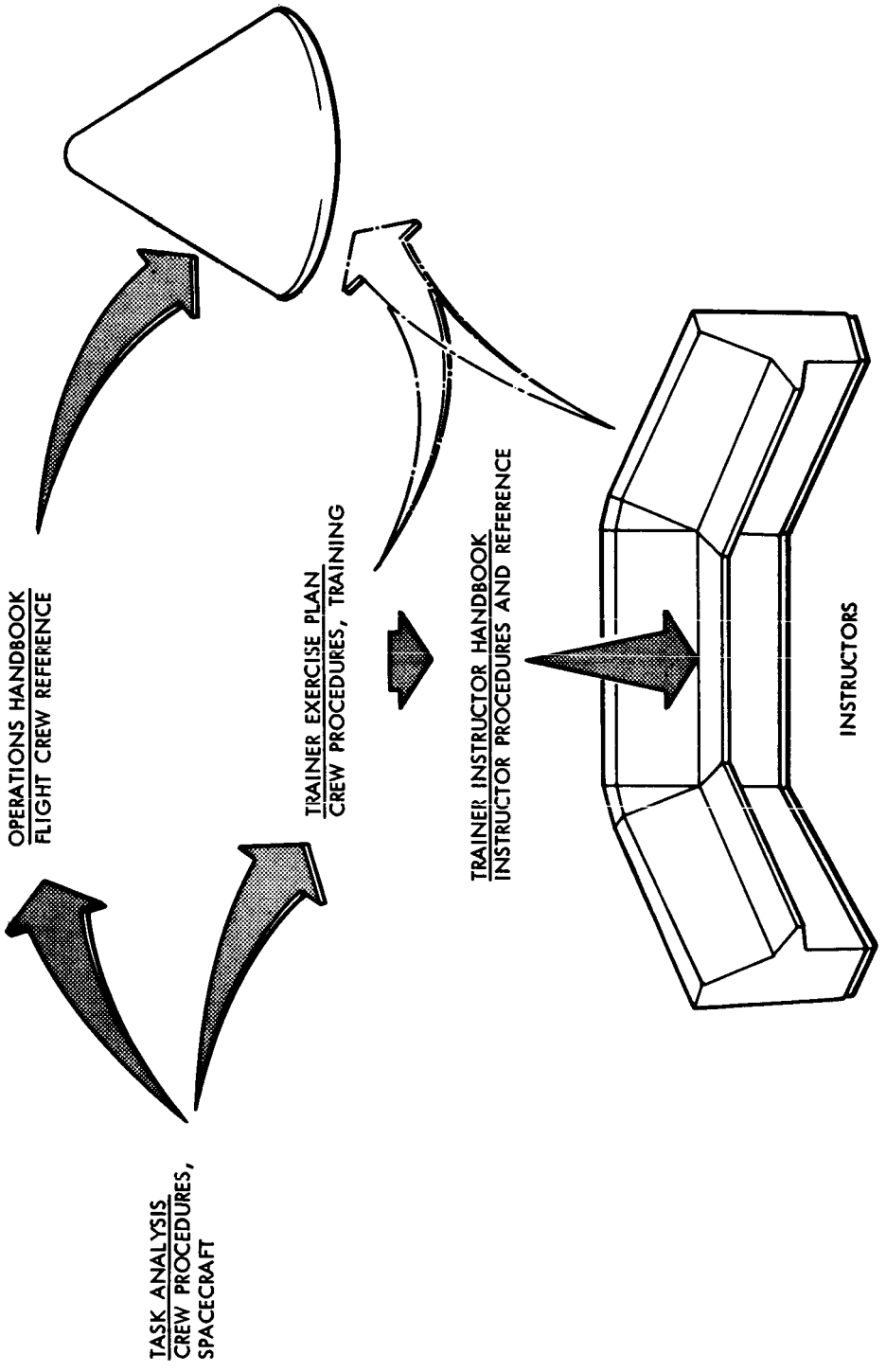

Figure 7-2. Trainer Procedures and References

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required for effective training. The operations handbook will provide specific instructions for the flight crew, as the trainer instructor handbook does for the instructor.

7.2.1 Description

Section one of Volume I describes the simulator in terms and depth sufficient to allow the instructor to become thoroughly familiar with the equipment. The description is supplemented with illustrations of the major equipment groups and operating stations. Tables keyed to the illustrations identify the controls and displays and briefly state the function of each.

7.2.2 Operation

Section two of Volume I contains the procedures for preparing and operating the simulator. The instructions include the preoperational readiness check, loading the computer programs, setting up for data transcriptions, initiating the selected program, running the program, and shutting down the trainer.

7.2.3 Syllabi

Section three of Volume I provides the recommended syllabi of training sessions and detailed instructions for utilizing the handbook contents in preparing instructor scripts for each training session. Two types of data are required—instructor console and telemetry console. The syllabi include a general definition of the exercises and sessions, a discussion of how they relate to each other, and a recommended sequence of training accomplishment. The most gross identification of syllabi materials is by type of training. The types of training for purposes of the instructor handbook are the different modes of training utilization of the AMS. Six are identified as follows:

Part task training (PT)
Crew procedures training (CP)
Typical mission training (TM)
Typical mission integrated training (TM-I)
Specific mission training (SM)
Specific mission integrated training (SM-I)

7.2.4 Session Data

Section one of Volume II provides detailed instructions for utilizing the handbook contents in preparing instructor scripts for each training session identified in the syllabus. The detailed instructions are comprised

of a description of each session and tabular information identifying those data increments required to prepare corresponding instructor scripts. The session descriptions and tabular data are removable for copying.

7.2.5 Computer Programs

Section four of Volume I describes all of the computer programs. The descriptions cover the scope of each program, the required entry points, and corresponding initial conditions. Simplified flow diagrams illustrate the normal start and end points, required alternate entries, gross initial conditions, and the subroutines into which the program will branch for malfunctions and aborts.

7.2.6 Training Task Data

Section two of Volume II contains instructor oriented descriptions of crew procedures for operating spacecraft systems. Operational procedures referenced in this initial configuration preliminary are those provided by Apollo Flight Crew Task Analysis. Operational crew procedures will ultimately be those provided in SM2A-03 (Apollo Operations Manual-Command and Service Module). The crew tasks described by Task Analysis (and ultimately SM2A-03) are grouped, subdivided, or directly incorporated into a set of training tasks that are suitable as building blocks for construction of training sessions identified in the syllabus. Each training task is separately described by means of an illustration of affected instructor console displays, depicting the procedure as it is manifested to the instructor. These illustrations are identified as training task data sheets.

7.2.7 Training Tasks

Section five of Volume I contains a general discussion of the training task data sheets. All training tasks are defined at topic level, and flow diagrams and tables are used to explain how training tasks relate to each other and to operational procedures.

7.2.8 System Simulation

Section six of Volume I contains the information required by the instructor for selecting simulated malfunctions. The section includes a discussion of the extent to which the spacecraft systems are simulated and the nature of such simulation. Each discussion is supported with a spacecraft system data flow drawing in which the malfunctions simulated are depicted in spacecraft terms.

7.3 INSTRUCTOR SCRIPT PREPARATION

The process of preparing an instructor script for a selected session involves four steps.

1. The session description and related tabular information are removed from Section one of Volume II.

2. Training task data sheets from Section two of Volume II are removed in accordance with the tabular data sheet from Section one.

3. All removed data are copied and returned to the appropriate place in the handbook.

4. The copied pages are arranged and annotated in accordance with instructions provided in the tabular data from Section one.

7.4 HANDBOOK SCHEDULE

The handbook schedule is shown in Figure 7-3.

The AMS Workbook was reviewed by NASA in a meeting on 30 September 1964 at S&ID, Downey. During this review, Apollo Training demonstrated the usability of the handbook by conducting a training session using a full-sized pasteboard mockup of the instructor operating station panels.

The following items will be excluded from the preliminary issue of the handbook.

1. Typical mission syllabus in its entirety

2. Specific mission syllabus in its entirety

3. Telemetry data sheets to accompany the training task data sheets

The training material for both the preliminary and the final issue of the AMS Instructor Handbook will be constrained by the capability of the initially delivered Apollo mission simulator.

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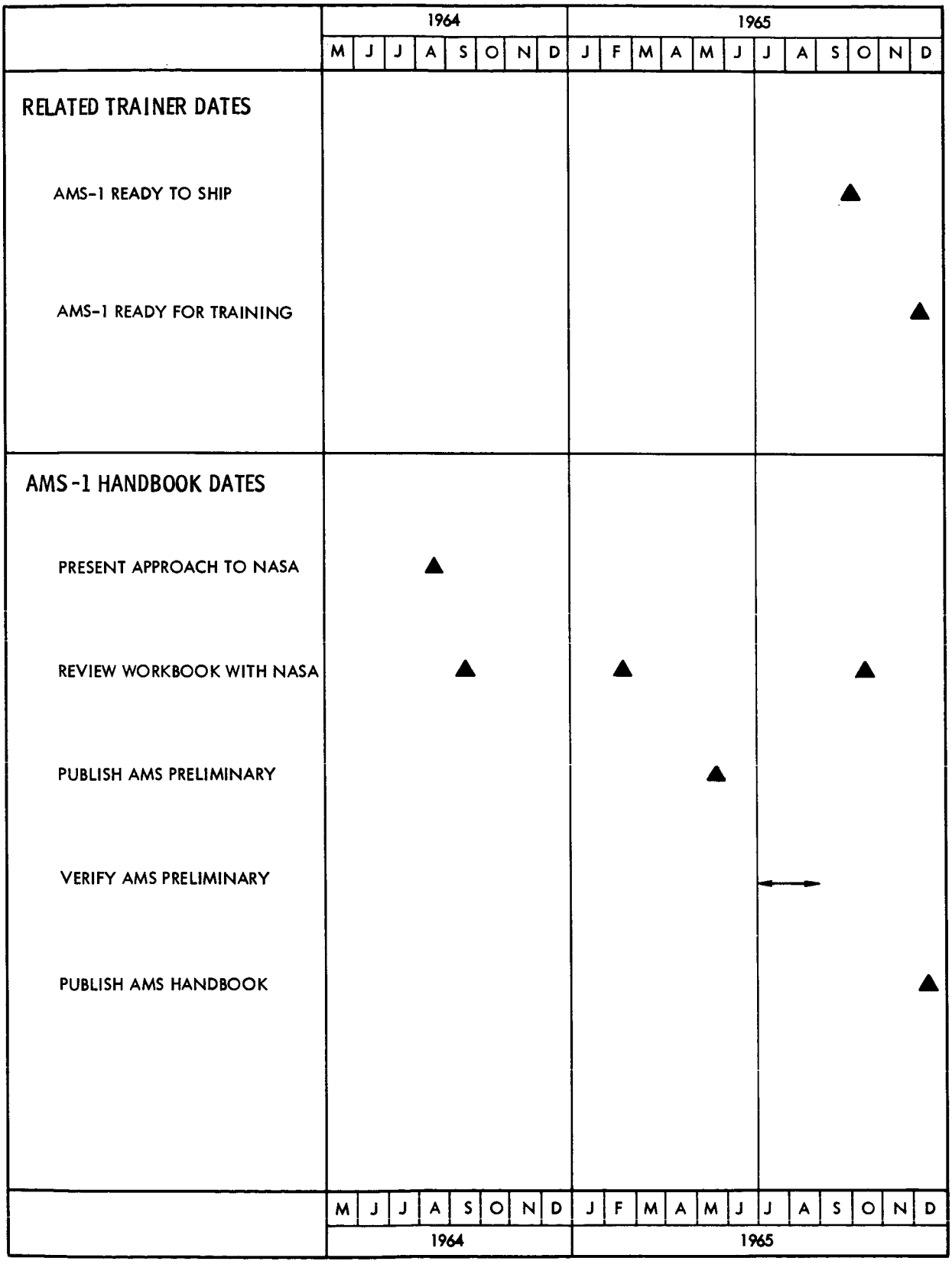

Figure 7-3. AMS Instructor Handbook Schedule

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8.0 S&ID COURSES OF INSTRUCTION

8.1 PURPOSES OF TECHNICAL BRIEFINGS

Apollo technical training briefings are intended to provide S&ID and NASA personnel with an effective and expedient means of obtaining systems, and systems interface, information. The briefings serve five important purposes in the Apollo training program:

1. To provide comprehension and technical vocabulary to those persons indirectly involved in the aspects of the program that constitute the briefing subject material

2. To provide interim training for directly involved personnel prior to the availability of Apollo training courses

3. To orient transient or reassigned personnel to new work assignments

4. To provide visibility of all aspects of the Apollo program to staff and headquarters agencies

5. To update previously trained personnel with current and timely Apollo information

8.2 COURSES AVAILABLE

Table 8-1 contains a list of the Apollo technical training briefings presently being provided by S&ID. A short description of the contents of each briefing is included in the table. Each briefing will provide an introduction to all related ground support equipment to the limit of information available. The guidance and navigation system briefing is only an introduction to the subject.

The briefings listed are used by S&ID to train both S&ID and NASA personnel. Apollo briefings at S&ID's Downey facility are conducted in accordance with a regular monthly schedule. Apollo briefings at the various NASA sites are arranged by the cognizant project officer in MSC-ASPO.

Apollo training briefings are conducted with overhead projector transparencies, 35-mm slides, magnetic aids and movies provided by S&ID.

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Table 8-1. Apollo Technical Training Briefings

APOLLO SPACECRAFT FAMILIARIZATION	6 HR
This course includes a brief description of the Apollo spacecraft, its systems and its mission. The launch vehicles used in the Apollo program are also described. The course is designed specifically for persons new to the Apollo program. It will acquaint them with the names and functions of the various components of the spacecraft and the terminology used in the program. This course is a recommended prerequisite for all Apollo systems briefings.	
APOLLO SPACECRAFT SYSTEMS FAMILIARIZATION	24 HR
This course is directed at those individuals requiring an overall knowledge of all Apollo spacecraft systems. It includes a discussion of the function and components of each major system, with emphasis placed on redundant components and alternate modes of operation.	
APOLLO ELECTRICAL POWER SYSTEM BRIEFING	12 HR
This course provides the student with a basic understanding of the electrical power system in the Apollo spacecraft (excluding the LEM). This will include power generation and distribution. Power generation will encompass a description of the fuel cells, battery charger, and inverters. Power distribution will include the bus system, protective devices, and controls and displays.	
CREW SYSTEMS BRIEFING	16 HR
This course is designed to acquaint the student with the following Apollo systems and equipment, defined as crew systems: crew couch and restraint system, lighting equipment, crewman equipment, food and associated equipment, waste management system and equipment, personal hygiene equipment, medical equipment, survival provisions, personal communications equipment, Government furnished equipment, and storage.	
STRUCTURES AND MECHANICAL SYSTEMS BRIEFING	24 HR
This course is designed to acquaint the student with the following modules of the Apollo spacecraft: launch escape tower, command module, service module, and spacecraft LEM adapter. In addition to spacecraft configuration information and materials description, spacecraft mechanical systems description and operation are included. The	

Table 8-1. Apollo Technical Training Briefings (Cont)

mechanical systems covered are: spacecraft separation system devices (excluding earth landing system devices), command module mechanism, and impact attenuation system.	
APOLLO TELECOMMUNICATIONS SYSTEM BRIEFING	44 HR
This course includes a familiarization and block diagram theory of operation of the Apollo communication and data subsystem, and the interface relationships of the equipment. The course is designed for people who require an overall knowledge of the communications system and the system interface.	
APOLLO ENVIRONMENTAL CONTROL SYSTEM BRIEFING	30 HR
This course includes a discussion of the functions and subsystems of the environmental control system. Functions of the various components associated with the system, normal operation, and alternate modes of operation are discussed.	
APOLLO STABILIZATION AND CONTROL SYSTEM BRIEFING	60 HR
This course will acquaint the student with the functional description and operation of the Apollo stabilization and control system (SCS). Discussion will be on the block diagram level, with related detailed presentation on unusual concepts. Included are description of modes of operation, displays, system interfaces, manual inputs, and signal flow analysis of SCS channels. Emphasis will be on control and display tie-ins with SCS mode selected.	
APOLLO GUIDANCE AND NAVIGATION SYSTEM BRIEFING	16 HR
This course is designed to acquaint the student with the components of the guidance and navigation system, control loops within the system, interface with other Apollo systems and system control modes. An understanding of inertial sensors, servo loops, digital computers and inertial navigation are prerequisites for this course.	

Table 8-1. Apollo Technical Training Briefings (Cont)

APOLLO AUTOMATIC SEQUENCE CONTROL SYSTEM BRIEFING	20 HR
This course describes the sequence of events that occur during the ascent and recovery phases of a typical Apollo mission. The major components of the three systems (ELS, LES, and EDS), including the controls and displays, are also discussed.	
APOLLO PROPULSION SYSTEMS BRIEFING	40 HR
The command module reaction control system, service module reaction control system, and service propulsion system will be discussed. Functional and descriptive information will be illustrated with block flow diagrams, electrical schematics, fluid system schematics, illustrations, and supporting engineering data. Interface to other systems will be defined and explained.	
ACE FAMILIARIZATION BRIEFING	8 HR
This course includes a brief description of the acceptance checkout equipment, its capabilities and its mechanization. It is designed for those desiring general information on ACE capabilities and spacecraft systems interface. Included is a definition of the units and the terminology used.	
ACE SYSTEMS FAMILIARIZATION BRIEFING	30 HR
This course provides system-level technical description of the acceptance checkout equipment. Sufficient detail is included to provide a clear understanding of functional equipment operation. This course is especially oriented to spacecraft systems personnel requiring ACE interface information, as well as those assigned to other ACE functions.	
ACE OPERATOR BRIEFING	100 HR
This course provides a familiarization with the operational requirements of the acceptance checkout equipment: spacecraft computerized test equipment and the basis for evaluation of the resulting test displays. The course is designed primarily for those personnel who will utilize the ACE station to test the spacecraft. General Electric-Daytona Beach and S&ID combine their efforts to present this course. For 60 hours, GE will present the ACE control and computer rooms. For 40 hours, S&ID will present ACE up-link and down-link, as well as peripheral, GSE.	

Table 8-1. Apollo Technical Training Briefings (Cont)

SITE FAMILIARIZATION BRIEFING	9 HR
The course provides a brief description of the overall concept of the spacecraft instrumentation and test equipment. The interface relationship of SITE and other spacecraft equipment is also included.	
SITE OPERATION MAINTENANCE BRIEFING	48 HR
This course provides a detailed description on the operation and maintenance of the spacecraft instrumentation and test equipment. Emphasis is placed on manual and tape programming for SITE operation and on programming of the fault isolation routine for SITE maintenance.	
SITE TEST PROGRAMMER BRIEFING	30 HR
This course provides a description on the philosophy and interfaces of SITE sufficient to assist personnel in writing the test programs for SITE. Personnel attending this course should already be familiar with the spacecraft instrumentation and test equipment.	
FLIGHT PROGRAMMER BRIEFING, SPACECRAFT 009	9 HR
The course provides a description of the programmer and its functional operation. The course will also include the spacecraft systems and ground support equipment interface with the programmer and the sequencing of events for various modes of operation.	

To accommodate student groups requiring different levels of detail and/or having varying amounts of time available for training, briefings are available in a variety of time lengths. The maximum briefing length for each topic will be as noted in Table 8-1.

Spacecraft system briefings that include detail theory of operation and troubleshooting procedures will soon be available and will require approximately twenty percent more time than stated in Table 8-1.

8.3 STUDENT MATERIALS

Student study guides are available for the following technical training briefings: Electrical Power System, Crew Systems, Structures and Mechanical Systems, Telecommunications Systems, Environmental Control System, Stabilization and Control System, Automatic Sequence

Control System, and Service Propulsion System. These study guides are designed to be used as a supplement to the briefings. Each one is organized in the same order as the briefing and provides most of the pictorial and schematic illustrations used by the instructor. This organization of material reduces the need for student note taking, yet provides an excellent format for notes when desired. A student study guide can be used independent of the briefing, but it is considered to be much less effective.

8.4 S&ID/GAEC COMMON USE GSE TRAINING

This training will be provided by Apollo Logistics Training personnel for GAEC personnel. It will increase the level of knowledge of competent technicians and/or quality control inspectors to the point of independent operation, maintenance, and inspection of common use GSE.

The detail plan of action for the training is provided by the Common Use GSE Training Plan for GAEC, SID 64-1690, dated 15 September 1964.

8.5 OTHER S&ID CONTRACTOR TRAINING

An S&ID Training Plan is being developed primarily to inform S&ID management and employees of the many training programs that are available both on company time and after normal working hours. In addition, the plan will provide the customer with a single source of information about S&ID's policy for the training and education of employees, and the methods used within S&ID to upgrade the individual's skills and to develop his capabilities of producing a highly reliable product on time and within budget.

9.0 S&ID SUPPORT

9.1 APOLLO LOGISTICS TRAINING DEPARTMENT

Apollo training and training planning at S&ID are the responsibility of the Apollo Logistics Training Department. The training services include all Apollo training for S&ID personnel and the Apollo training services to NASA for which S&ID is contracted.

9.2 TRAINING PLANNING AND ACCOMPLISHMENT

Figure 9-1 illustrates the manner in which S&ID is planning and accomplishing Apollo training. Since Apollo Logistics Training serves NASA and S&ID in identical fashion, both efforts are depicted in the flow diagram.

9.3 EQUIPMENT SOURCE DATA

Because S&ID is the spacecraft designer and manufacturer, and the Apollo mission comprises the operation of spacecraft equipment, spacecraft design engineering activities are the prime source of Apollo training data.

Apollo Logistics Training maintains direct personal contact between instructors and design engineers throughout the plant.

Apollo Logistics Training is represented on the Apollo Change Control Board. The nature, effect, and status of in-process changes is closely monitored by instructors and reflected in training presentations.

In order to develop Apollo training, it is necessary for instructors to conduct extensive research into spacecraft systems and to translate engineering data into training information. Apollo Logistics Training formalizes training research by preparing a student study guide for each spacecraft system briefing. These student study guides are the subject of Section 8.3.

9.4 PERSONNEL PERFORMANCE SOURCE DATA

The tasks involved in the training subjects' ultimate job assignments form the basis for all detailed training requirements. Identification of all detailed Apollo training requirements includes direct reference to ultimate job applications.

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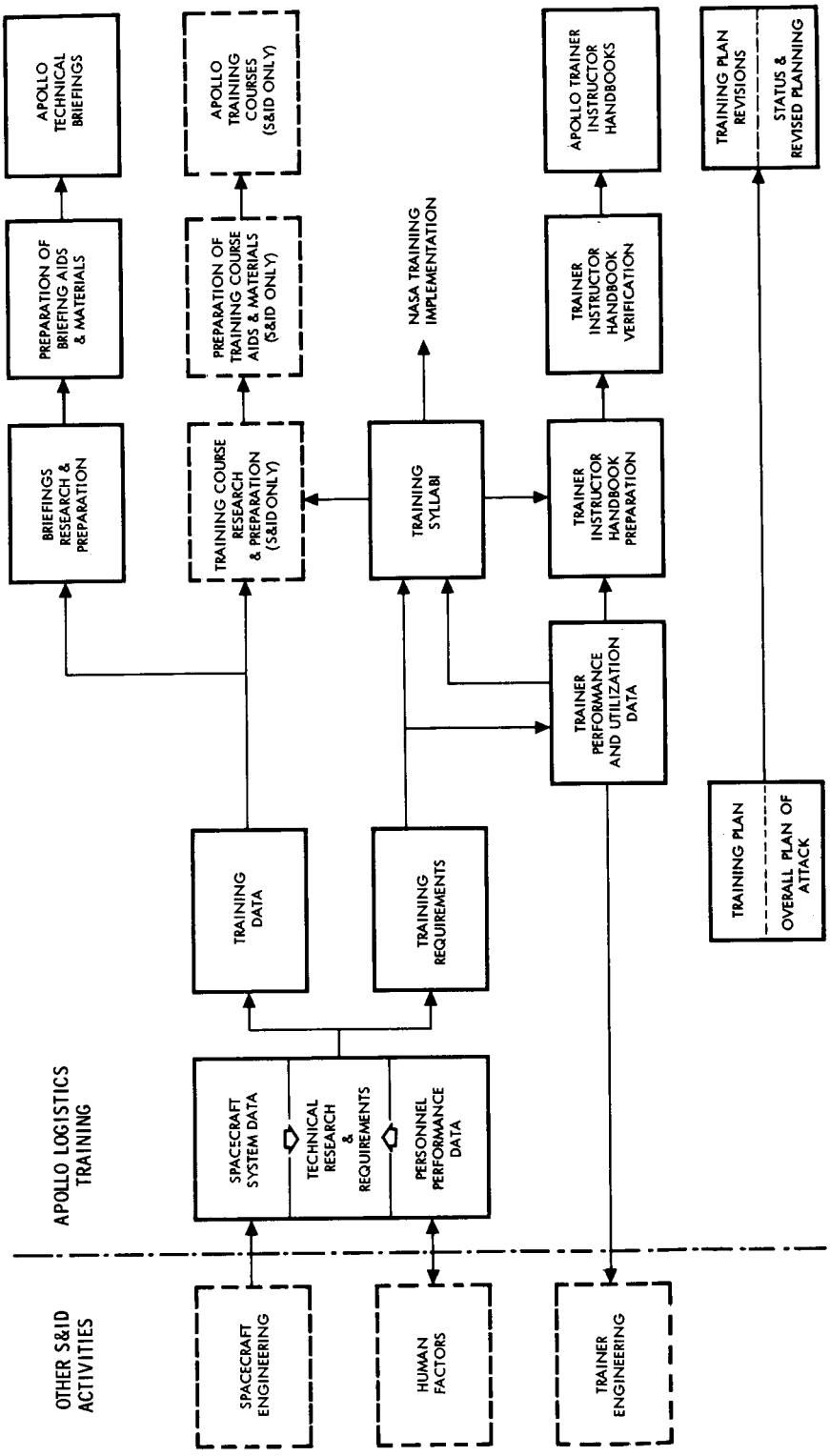

Figure 9-1. Apollo Logistics Training Work Flow

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Identification and detailed definition of ultimate job performance are provided by the Apollo Human Factors Department and closely coordinated with Apollo Logistics Training. The training department is supported by Human Factors with the following:

1. Task identification and description. In the case of the flight crew, this information takes the form of the integrated Apollo flight crew task analysis. The use of task analysis in training is discussed in Paragraph 7.2.6 of this plan.

2. A gross indication of task difficulty and the type of skill required to accomplish this task.

9.5 TECHNICAL RESEARCH AND REQUIREMENTS

The assembling of the training material and the identification of specific training requirements are simultaneous and totally interrelated. During the initial phases of program development, source data of a general nature are analyzed, and gross and tentative training requirements are identified. Then, the accuracy, detail, and validity of requirements are improved by two simultaneous processes.

1. Initial identification of training requirements provides improved frames of reference for researching training needs, resulting in more and better source information, more valid and accurate requirements, improved frames of reference for research, etc.

2. The detail, volume, and accuracy of source data increase as a function of program development. And, as training achieves a greater and greater capability to recognize and apply pertinent data, more and more data become available.

9.6 SUPPORT OF TRAINING EQUIPMENT DEVELOPMENT

The needs for training equipment and the trainer performance entailed in fulfilling them are inherent in definitive training requirements. Apollo Logistics Training places special emphasis on identification of trainer and trainer performance requirements as an integral part of overall training planning. These requirements are given to the Simulation and Trainers Engineering Department as basic performance requirements criteria.

As specific training equipment is identified and defined, Apollo Logistics Training prepares detailed plans for its utilization. This information is integral to the detailed planning of training. Utilization

information is also provided to the Simulation and Trainers Department as detailed trainer performance requirements. Specific trainer utilization plans are the subject of Sections 2.10 and 2.11.

The final result of Apollo Logistics Training support of training equipment development is the instructor handbooks provided to the customer with Apollo training equipment. The handbooks will provide instructions in how to use the training equipment most effectively to accomplish the intended training purpose. Preparation of Apollo trainer-instructor handbooks, the responsibility of Apollo Logistics Training, is discussed at length in Section 7.0 of this plan.

9.7 TRAINING PREPARATION AND CONDUCT

Training at S&ID is divided into two general categories, training courses and technical briefings, each serving a separate purpose:

1. Training Courses—Apollo training courses are conceived with the intention of qualifying the trainee to perform specific working tasks that directly affect the Apollo mission and/or Apollo equipment performance.

2. Technical Briefings—Apollo technical briefings are conceived for the purpose of imparting knowledge rather than developing performance capabilities. Technical depth of S&ID briefings ranges from orientation to detailed engineering discussion.

The basic criteria for preparation of each training course are established by a syllabus which specifies, according to training requirements, the following details:

1. Performance capabilities to be achieved

2. Types of training to be used

3. Trainer or training aids required

4. Manner of aid or trainer utilization

5. Approximation of time required

Course preparation on the basis of training syllabi includes devising an hour-by-hour course outline, preparing trainee exercises and aids, and making all other detailed arrangements relevant to initiating the training course.

The Apollo Logistics Training responsibility to prepare and conduct training courses presently applies only to S&ID training.

Technical briefings are presently being provided for both S&ID and NASA. Apollo Logistics Training services in this area are discussed in detail in Sections 8.1 through 8.3 of this plan.

9.8 TRAINING PLAN

The Apollo Training Plan, a responsibility of the Apollo Logistics Training Department, calls for the preparation and updating of an overall plan of action for Apollo training. Revisions of the plan include reports on the status of in-process training activities being performed in accordance with the plan.

9.9 SUMMARY

A summary of Apollo Logistics Training activities and their products is provided in Table 9-1.

Table 9-1. Apollo Logistics Training Activities and Products

Activity	Product
Program planning	Apollo Training Plan
Spacecraft systems research	Student study guides
Determination of training requirements from personnel performance data	Training requirements
Assessment of data for effective training methods	Recommendations for training and training equipment
Organization of training requirements into an effective plan for training accomplishment	Training syllabi
Development of an effective approach to trainer utilization	Trainer utilization plans
Development of operational documentation for trainer utilization	Trainer instructor handbooks
Preparation of familiarization briefings	Instructional materials, aids, and devices
Presentation of familiarization briefings	Training services
Preparation of system technical briefings	Instructional materials, aids, and devices
Presentation of system technical briefings	Training services
Preparation of training courses (for S&ID only)	Course outlines; training exercises; instructional materials, aids, and devices; and training measurement standards

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3. Mission Training Simulator Utilization Plan (Preliminary). Enclosure to letter E. M. Pollard to J. Robertson, dated 2 September 1964. Subject: Preliminary MTS Utilization Plan (Manned Missions 203A, 204A, 205A, and 506A).

4. Definitions and Objectives of Apollo Hardware Test Articles. NAA-S&ID 62P1-695-420-1 (15 November 1963 issue with revision pages).

5. Apollo Hardware Utilization List. NAA-S&ID 63 TO-695-322-2 (15 November 1964 issue with revision pages).

6. Plan for Preparation of the Catalogs of Malfunctions To Be Used in the APTT and AMS. SID 69-913 (April 1964).

7. MTS and APTT Malfunction Selection Catalog. SID 64-1638 (11 September 1964).

8. Apollo Schedule Manual. NAA-S&ID (5 October 1964).

9. Apollo Flight Crew Performance Specification. SID 62-90 (15 July 1964).

10. Contract Change Authorization 164, Revision 1, dated 25 June 1964.

11. Supplemental Agreement No. 60, dated 27 October 1964.

12. Ground Support Equipment Planning and Requirements List. SID 62-417 (1 January 1965).

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APPENDIX A

SYNOPSIS - PLAN FOR APOLLO FLIGHT CREW TRAINING ON THE APOLLO PART TASK TRAINER

APOLLO PILOTING PART TASK EXERCISES
PT. 1 Mid-Course Attitude Control
This exercise involves one man in the trainer in the command station. The trainer program is for mid-course. The purpose of the exercise is to introduce the astronaut to the controls and indicators used in controlling spacecraft attitude. Training includes all aspects of mid-course attitude control including: The various modes of stabilization and control system (SCS) operation, service module reaction control system (RCS) engines failure to fire, channel disables, and sensitivity variations resulting from mass and c.g. shift.
PT. 2 Orbital Attitude Control
Again, the exercise involves one man in the trainer command station but this exercise requires the orbital trainer program. The exercise is for the purpose of expanding attitude control training to include earth and lunar orbit procedures. Training includes all aspects of operating the RCS system in both lunar and earth orbit. Such training involves: various modes of SCS operation, RCS engines failure to fire, channel disables, sensitivity variations resulting from mass and c.g. shift, and the effects of translational components on trajectory characteristics.
PT. 3 Command Module Attitude Control
Further training in Apollo attitude control is required in the area of spacecraft orientation for entry and reentry. Such training is the purpose of this exercise. Training is accomplished with one astronaut in the command station. Two modes of spacecraft response to RCS firing are involved. The first is the free-fall response at the time of entry orientation, and the second is the aerodynamic response during entry. Training in both is to be accomplished in this exercise. Training is to include: entry orientation, normal entry procedures, interpretation of cross range and down range data as provided by the guidance and navigation (G&N) display,

PT. 3 Command Module Attitude Control (Cont)
various stabilization and control system (SCS) modes, RCS engines failure to fire, channel disables, and SCS backups.
PT. 4 Basic Procedures, SPS Firing
This exercise requires the trainer program for mid-course and involves one astronaut in the command station. Training purpose is to train the astronaut in basic ΔV procedures and their variations. Training includes: basic command station procedures (with pre-established ΔV, attitude, and gimbal set requirements) in various SCS modes with manual override requirements and rotational moment arm contingencies.
PT. 5 Prelaunch, Launch, and Ascent Procedures (Station 1)
The launch and ascent program will be required to provide the astronauts with training in Station 1 launch and ascent procedures. Since ascent training amounts to little or nothing without both the continuous possibility and random occurrence of aborts, abort training is also incorporated. Training includes: Station 1 prelaunch procedures, astronaut analysis of the ascent trajectory and recognition of abort requirements, analysis of booster performance and recognition of abort requirements, normal ascent procedures, manual override of automated functions, and abort procedures for Station 1.
NOTE: Completion of Exercises PT. 1, PT. 2, PT. 3, PT. 4, and PT. 5 comprises all of the Station 1 training required by individual astronauts prior to participation in crew exercises.
SPACECRAFT NAVIGATION PART TASK EXERCISES
PT. 6 Mid-Course Navigation
This exercise involves one man in the trainer lower equipment bay station. The trainer program is for mid-course. The purpose of the exercise is to introduce the astronaut to the controls and indicators of the lower equipment bay navigation station and the procedures for routine navigation sightings and Apollo guidance computer operation. Training will include use of the sextant and telescope, solution of navigation problems with the AGC, and programming of computer controlled events. G&N and SCS malfunctions affecting navigation procedures are also incorporated.

PT. 7 IMU Alignment
Training for this exercise again involves one man in the lower equipment bay and the mid-course trainer program. Training will include normal procedures for coarse and fine alignment of the IMU. Malfunctions of the G&N and SCS systems affecting such procedures will also be incorporated.
PT. 8 Earth Orbital Navigation
The orbital trainer program will be required for this exercise with one man at the G&N station in the lower equipment bay. The purpose will be to train the astronaut in procedures for earth orbital navigation. Training will include navigation sightings and solutions, and IMU alignment, and will deal with G&N and SCS malfunctions affecting navigation procedures.
PT. 9 Lunar Orbital Navigation
Again, one man in the lower equipment bay and the lunar orbital program are required. The purpose and scope will be the same as for PT. 8 but will incorporate lunar orbital navigation procedures rather than those for earth orbit.
NOTE: Completion of Exercises PT. 6, PT. 7, PT. 8, and PT. 9 comprises all of the lower equipment bay G&N station training required by individual astronauts prior to participation in crew exercises.
SYSTEM PROCEDURES PART TASK EXERCISES
PT. 10 and PT. 11 Periodic and Special System Procedures
Training in the myriad simple system procedures to be accomplished at Stations 2 and 3 of the spacecraft during earth orbit, mid-course, and lunar orbit are included in these exercises. PT. 10 is for the orbital trainer program and PT. 11 is for the mid-course program. Most of the training involved can readily be accomplished with either trainer program. Training involves one man in the trainer, using both Stations 2 and 3 controls and indicators. Training includes service propulsion system management, reaction control system management, electrical power system operation and management, environmental control system operation and management, and spacecraft communications and data system operation and management.
PT. 12 Prelaunch, Launch, and Ascent Procedures (Station 3)
This exercise involves the use of the trainer launch and ascent program with one man in Station 3. Its purpose is to train the astronaut in

PT. 12 Prelaunch, Launch, and Ascent Procedures (Station 3) (Cont)

the prelaunch, launch, ascent, and abort procedures to be accomplished by the Apollo crewman in Station 3. Training includes Station 3 prelaunch procedures from T-24 to T-2, and launch and ascent procedures from T-3 to T+15. Malfunctions will be used to establish non-readiness and abortive situations.

PT. 13 Prelaunch, Launch, and Ascent (Station 2)

This exercise is for the same purposes as PT. 12 but is for Station 2 procedures. Again, the launch and ascent trainer program is required. Training includes Station 2 prelaunch procedures from T-15 to T-2 and launch and ascent procedures from T-2 to T+15. Malfunctions will be used to provide training in non-readiness and abortive situations.

NOTE: Completion of all PT. Exercises 1 through 13 comprises all of the training required by individual astronauts prior to participation in crew exercises.

MISSION SEGMENT EXERCISES

MS. 14 Crew Tasks, Earth Orbit

This exercise involves two and three man crews in the APTT for practice of the following Apollo mission segments and tasks:

1. Navigation sightings and system procedures during parking orbit – three men in Stations 1, 3, and 4
2. Preparation for translunar injection – three men in Stations 1, 3, and 4
3. Mission termination procedures from parking orbit – three men in Stations 1, 2, and 3
4. Navigation sightings and system procedures during earth orbital mission – three men in Stations 1, 3, and 4
5. Navigation sightings and system procedures during earth orbital mission – two men
6. De-orbit procedures, earth orbital mission – three men in Stations 1, 2, and 3

MS. 15 Crew Procedures, Mid-Course

This exercise involves two and three man crews in the APTT for practice of the following Apollo mission segments and tasks:

1. Crew procedures for translunar injection and initial mid-course (excluding transposition and docking) – three men in Stations 1, 2, and 3
2. Navigation sightings and routine system procedures in mid-course coast – two men
3. IMU alignment and ΔV procedures during mid-course – two men
4. Preparations for translunar injection – three men in Stations 1, 3, and 4
5. Procedures for transearth injection and initial mid-course – three men in Stations 1, 2, and 3
6. Procedures for preparing for final mid-course correction – three men in Stations 1, 2, and 4
7. Procedures for performing final mid-course correction – three men in Stations 1, 2, and 4
8. Procedures for final navigation sightings and preparation for service module jettison and entry – three men in Stations 1, 2, and 4

MS. 16 Crew Tasks, Lunar Orbit

This exercise involves a three man crew in the APTT for practice of the following Apollo mission segments and tasks:

1. Crew procedures for translunar injection and initial lunar orbit – three men in Stations 1, 2, and 3
2. Preparations for transearth injection – three men in Stations 1, 3, and 4

NOTE: How to best organize the balance of Apollo part task trainer training in lunar orbit procedures for the three man crew is still under investigation by S&ID.

MS. 17 One Man Operation, Lunar Orbit
Two distinct aspects of the training required have been identified for one-man procedures in lunar orbit. The first is the normal procedures that must be accomplished while the lunar excursion module (LEM) is away. The second is the extreme contingency of one-man survival in the event that the LEM is not recovered. This contingency is still under investigation by S&ID.
MS. 18 One-Man Operation, Transearth
This training requirement is also under study by S&ID. Training again relates to the extreme contingency of one man survival in the event the LEM is not recovered.
MS. 19 Crew Task, Service Module Jettison and Entry
This exercise involves a three man crew in the APTT for practice of the following Apollo mission segments and tasks: 1. Accomplishment of service module jettison and entry from trans-earth trajectory – three men in trainer in Stations 1, 2, and 3 2. Accomplishment of service module jettison and entry from earth orbit – three men in trainer in Stations 1, 2, and 3
MS. 20 One Man Operation, Service Module Jettison and Entry
Again, the training requirement relates to the extreme contingency of one man survival and is being investigated by S&ID.
MS. 21 Crew Tasks, Prelaunch, Launch, and Ascent
This exercise involves a three man crew in the APTT for practice of the following mission segments and tasks: 1. Prelaunch procedures from T-24 to T-2 2. Normal launch and ascent procedures from T-4 through T+15 3. Procedures for launch escape system (LES) abort from 0 to 7000 feet

MS.21 Crew Tasks, Prelaunch, Launch, and Ascent (Cont)
4. Procedures for LES abort from 7,000 to 120,000 feet 5. Procedures for LES abort from 120,000 to 265,000 feet 6. Procedures for service propulsion system abort subsequent to LES jettison

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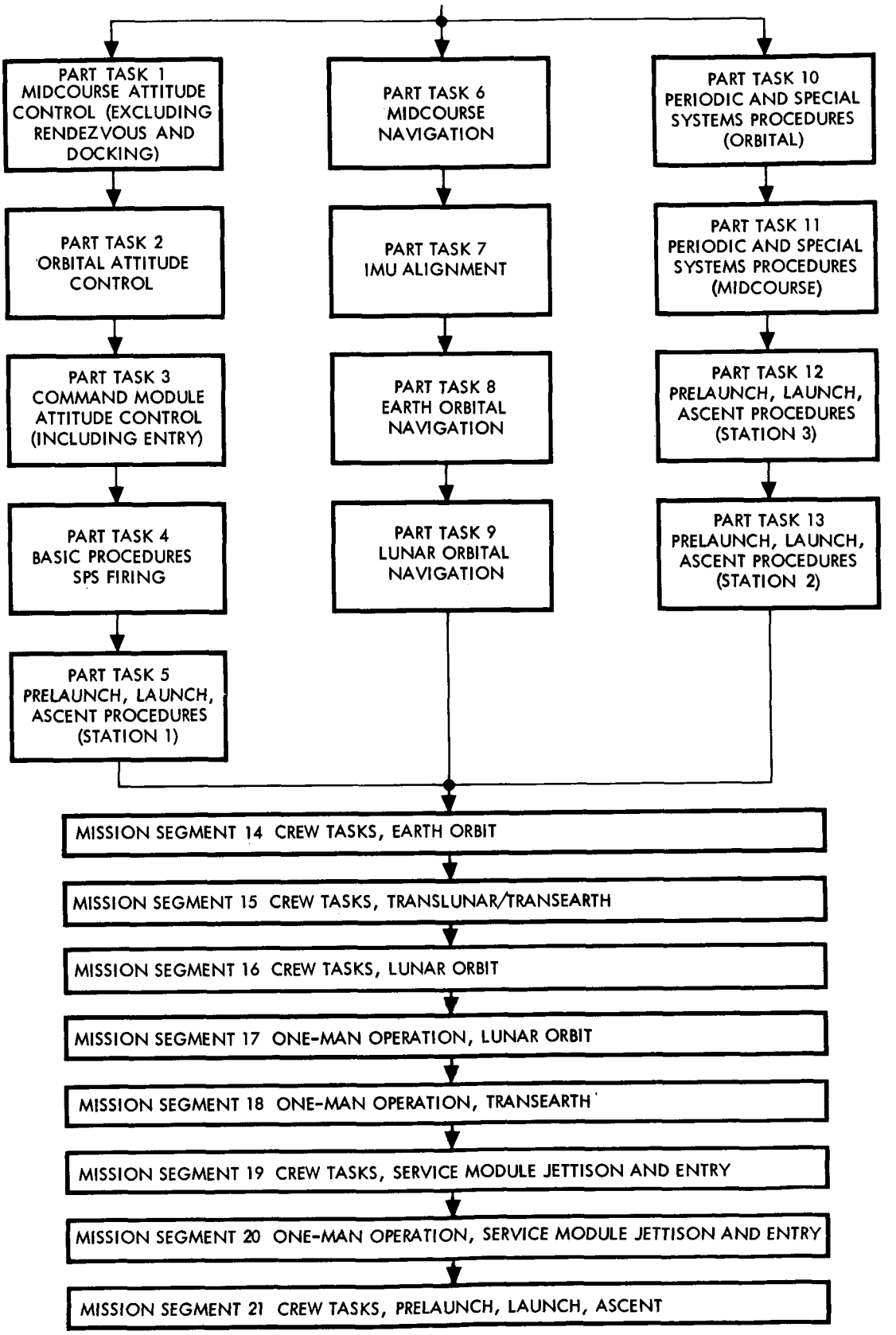

Figure A-1. Development Sequence, APTT Training Exercises

APPENDIX B

SESSION DATA SHEETS AND FORMAT

Appendix B includes a complete session data sheet format and some partial session data sheets taken from the in-process 1 February 1965 workbook copy of the AMS Instructor Handbook.

FORMAT

Session Data Sheet

Session Title	Session Number	Page Number
Purpose:		
Scope:		
Crew Procedures:		
Measurement Criteria:		
Instrumentation and Initializing Instructions:		
Programming and Initializing Instructions:		
Scripting Instructions:		
Scripting Worksheet:		

[redacted]

TYPICAL SESSION DATA SHEET ENTRIES

Session Data Sheet

Preparation for Entry	PT4.1	1
Purpose: To provide flight crew members with training in the procedures for CM-SM separation and preparation for entry		
Scope: Five training runs are required to accomplish this session. These are comprised of a walk through of procedures for Stations 1, 2, and 3, a practice of Station 1 procedures (G&N orientation), and an abbreviated run to be reiterated as many times as required for purposes of achieving a capability for entry orientation in the SCS mode. Runs are as follows: 1. Walk through of CM-SM separation and preparation for entry (Station 1) 2. Walk through of CM-SM separation and preparation for entry (Station 3) 3. Walk through of CM-RCS checkout and preparation for entry (Station 2) 4. Practice procedures for CM-SM separation and preparation for entry (Station 1, G&N mode orientation) 5. Practice SCS mode entry orientation (Station 1)		

[redacted]

Session Data Sheet

Entry and Descent (Station 1)	PT4.2	1

Purpose: To provide flight crew members training in the crew procedures for entry and descent to touchdown

Scope: The session consists of six training runs. The first is a walk through; the next three are practice in the G&N mode; and the fifth and sixth are practice runs in the SCS and manual direct modes, respectively. Runs five and six should be reiterated as many times as required to attain skill objectives. The runs are as follows:

1. Walk through G&N entry and descent, nominal trajectory (angle -3.0 degrees, velocity at 400K ft - 25.5K ft/sec)
2. Practice G&N entry and descent, nominal trajectory
3. Practice G&N entry and descent, high-g trajectory (angle -4.0 degrees, velocity at 400K ft - 25.5K ft/sec)
4. Practice G&N entry and descent, high-heat trajectory (angle -2.0 degrees, velocity at 400K ft - 25K ft/sec)
5. Practice SCS mode entry
6. Practice manual direct mode entry

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Session Data Sheet

Entry and Descent Contingencies (Station 1)	PT4.3	1

Purpose: It is the purpose of this session to complete Station 1 part task training in entry and descent procedures with a number of training runs, each involving one or more contingencies requiring Station 1 crew action. The contingencies have been selected to initiate requirements for performance of all significant tasks.

Scope: The total task of the flight crew member at Station 1 during entry and descent is three-fold. He must monitor G&N controlled entry, control entry in the SCS and manual direct modes where requirements dictate, and monitor and operate the ELS during glide and descent to touchdown. Recognition of requirements for alternate mode selection and/or manual overrides are inherent in all three aspects of the training. All training runs are from immediately after de-orbit to touchdown. Training runs are identified as follows:

1. Entry with azimuth error from de-orbit
2. Entry with ELS sequencing malfunctions
3. G&N failure prior to entry (requires SCS mode)
4. G&N failure during entry (requires SCS mode)
5. SCS failure prior to entry (manual direct mode)

Session Data Sheet

Launch and Ascent Procedures, Station 1	PT5.1	1

Purpose: To provide Apollo flight crew members with training in normal launch and ascent procedures and manual override of automated sequence event failures during ascent.

Scope: The scope of the session includes demonstration and practice of booster and launch escape tower sequencing as monitored by the crew via the EDS displays and GOSS voice data. Malfunctions are used to demonstrate requirements and procedures for overriding automated sequence events.

The session also includes demonstration and practice of procedures for monitoring launch ascent by means of the FDAI and AGC. In this case, emphasis is on problematical and abortive situations. Training runs involved are as follows:

1. Walk through of Station 1 launch and ascent procedure demonstrating normal sequence and malfunctions requiring override
2. Practice recognizing automated sequence failures during launch and ascent, and override as required.
3. Low velocity ascent (will not achieve orbit)
4. Normal ascent with cross-range error
5. Overshoot from booster cutoff failure

Note: AMS capability to provide training is contingent upon ascent trajectory simulation. Performance definition for the simulator is particularly vague in this area.

Session Data Sheet

LES Aborts, Station 1	PT5.2	1

Purpose: To provide flight crew members with training in Station 1 procedures for ground and crew initiated LES abort sequences. Emphasis is on (1) experience in the various sequences for different abort altitudes and situations, (2) recognition of requirements for and accomplishment of crew initiated aborts, and (3) expedient recognition and override of sequencing malfunctions.

Scope: This training session includes both crew and instructor initiated abort sequences. Multiple runs are used across a spectrum of altitudes for purposes of including all of the various LES abort sequences. Malfunctions are used to induce requirements for crew override of normally automated functions. Training runs are as follows:

1. Pad abort walk through
2. Low altitude LES abort
3. High altitude LES abort (7000 to 120, 000 ft)
4. High altitude LES abort (120, 000 to 265, 000 ft)
5. High altitude (120, 000 to 265, 000 ft) LES abort with sequencing malfunctions
6. High altitude (7000 to 120, 000 ft) LES abort with sequencing malfunctions
7. Low altitude LES abort with sequencing malfunction

Session Data Sheet

SPS Abort, Station 1	PT5.3	1
Purpose: To provide the flight crew member in Station 1 with practice of SPS abort sequences. Emphasis is on recognition of requirements to abort and on those procedures required to successfully accomplish SPS aborts.		
Scope: Three basic variations of SPS firing are involved. Each results in a separate training run. A walk through of SPS abort procedures prior to practice is also required. Training runs are as follows: 1. Walk through of SCS mode SPS abort to suborbital trajectory 2. SPS abort to suborbital trajectory (G&N mode) 3. SPS abort to orbit (G&N mode) 4. SPS abort to suborbital trajectory (SCS mode)		

Session Data Sheet

Launch and Ascent Contingencies, Station 1	PT5.4	1

Purpose: It is the purpose of this session to complete station part task training in launch and ascent with a number of launch and ascent runs, each involving one or more contingencies requiring Station 1 crew action. The contingencies have been selected to initiate requirements for performance of all significant tasks.

Scope: The total task of the flight crew member at Station 1 during launch and ascent is three-fold. He must monitor booster performance by means of the open line to GOSS; he must monitor the LES and booster sequences; and he must monitor the ascent trajectory by means of spacecraft displays and the open line to GOSS. Where aborts are involved, the requirements extend to include recognition of abort requirements, accomplishing abort sequences, and manual override of sequencing malfunctions. Seven runs are involved:

1. Launch and ascent to orbit run with requirements for crew override of LES malfunctions, booster staging malfunctions, and booster failure to cut off malfunctions.

2. Launch and ascent run terminated by a low altitude auto abort that includes requirements for crew override of sequencing malfunctions.

3. Launch and ascent run terminated by a crew-initiated high altitude abort (7000 to 120,000 ft), that includes requirements for manual override of sequencer malfunctions.

4. Launch and ascent run terminated by a crew-initiated high altitude abort (120,000 to 265,000 ft), that includes requirements for manual override of sequencer malfunctions.

5. Launch and ascent run terminated by a booster malfunction necessitating SPS abort to suborbital trajectory (G&N mode).

6. Launch and ascent run terminated by a G&N malfunction inducing requirements for an SCS mode SPS abort.

7. Launch and ascent run terminated by a booster malfunction necessitating SPS aborts to earth orbit (G&N mode).

Session Data Sheet

Prelaunch, Launch, Ascent	CP1.1	1
Purpose: To provide flight crew members training in the coordinated procedures for final launch preparations, launch, and ascent to orbit.		
Scope: The session includes all normal crew procedures from T-15 minutes to ground confirmation of orbit attainment. Simulated malfunctions are used to induce prelaunch holds and overrides of sequencing events during ascent. Three training runs are involved: 1. Walk through of prelaunch procedures 2. Practice normal prelaunch, launch, ascent 3. Practice prelaunch, launch, ascent with holds during prelaunch, and overrides during ascent		

Session Data Sheet

Pad and Low Altitude Aborts	CP1.2	1
Purpose: To provide flight crew members training in the coordinated crew procedures for ground and auto-initiated pad and low altitude LES aborts		
Scope: Except for manual override of sequencing malfunctions and communication of abort events, crew activities are limited to monitoring sequence events during pad and low altitude aborts. This session includes practice of these activities as initiated from both prelaunch and ascent situations. Training runs are as follows: 1. Walk through of pad abort 2. Practice pad abort 3. Practice low altitude abort 4. Practice pad abort with sequencing malfunctions 5. Practice low altitude LES abort with sequencing malfunctions		

Session Data Sheet

High Altitude LES Abort	CP1.3	1

Purpose: To provide flight crew members training in the coordinated crew procedures for high altitude LES abort

Scope: Crew activity during high altitude LES abort consists of recognition of requirements to abort, crew initiation of abort, monitoring abort sequences, fuel and oxidizer dump, and manual override of auto-sequenced events where required. Crew activity is primarily in Station 1. Training runs are as follows:

1. Walk through 7000 to 120,000 ft abort
2. Practice 120,000 to 265,000 ft abort
3. Practice 120,000 to 265,000 ft abort with sequencing malfunctions
4. Practice 7000 to 120,000 ft abort
5. Practice 7000 to 120,000 ft abort with sequencing malfunctions

Session Data Sheet

SPS Aborts, Suborbital, G&N Mode	CP1.4	1

Purpose: To provide flight crew members training in the coordinated crew procedures for SPS abort procedures in the G&N mode. The other two are practice runs to each of two alternate recovery areas. The runs are listed as follows:

1. Walk through of SPS abort procedures (G&N mode)
2. Practice SPS abort procedures (G&N mode) to recovery area No. 1
3. Practice SPS abort procedures (G&N mode) to recovery area No. 2

Session Data Sheet

SPS Abort to Orbit	CP1.5	1
Purpose: To provide flight crew members training in the coordinated crew procedures for SPS abort to earth orbit		
Scope: Two very lengthy runs are required for accomplishment of this training session. The first is a walk through from launch through touchdown. The second run is a practice session of the same scope. The two runs are listed as follows: 1. Walk through of complete SPS abort to orbit 2. Practice SPS abort to orbit		

Session Data Sheet

SPS Aborts, Suborbital, SCS Mode	CP1.6	1
Purpose: To provide flight crew members training in the coordinated crew procedures for SPS abort due to G&N system failure		
Scope: Two rather complex runs are required for this training session. The first is a walk through from launch through touchdown. The second is a practice session of the same scope. The second run should be reiterated several times under different circumstances for purposes of establishing a variety of targeting situations.		

Session Data Sheet

Launch and Ascent Contingencies	CP1.7	1

Purpose: Provide flight crew members with training in recognizing requirements to abort and in coping with initial system failures while accomplishing the abort.

Scope: The session is made up of four training runs. Two runs include abortive ECS failures that require special operation of the ECS system in addition to abort initiation. One run deals with abortive ECS failures. The fourth run contains abortive G&N malfunctions at a particularly critical point during the ascent. The runs are identified as follows:

1. Launch and ascent with abortive ECS malfunctions (high altitude LES)
2. Launch and ascent with abortive EPS malfunctions (at S-IVB ignition)
3. Launch and ascent with abortive G&N malfunctions (at LES jettison)
4. SPS abort with ECS alternate modes

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APPENDIX C. TYPICAL GSE TRAINING REQUIREMENTS DATA SHEETS

Date: March 18, 1964
Rev. Date: December 28, 1964
TADN: ME901-0031-0001

O&M GSE TRAINING REQUIREMENT

Model: C14-092

System: SCS

Nomenclature: BME, Stabilization & Control System

Downey: S/C 6,8,9,11,12,14,15,17, & 20 B/P 14 BME Area
MSC: S/C 8 Bldg. 36 (BME)
FF: S/C 9,11,12,14,15,17 & 20 O&C Building

Interchangeability: N/A

Responsible Engineering: J. M. Pomykata

Project Engineer: R. Robertson

Technical Reference: 62T0695-322-1, SID 62-417, MC901-0031B, UG1600-Minn-Hon, UG1601, Trygon Model M40-30-S491, EH Research Lab Inst. Man. 132A, A64-763.1A5 (2 & 2C)- Minn-Hon., QC Procedure Minn-Hon. 1374, Inst. Man. Model 412AR OCP #1000NAA, SM3A-501- Minn-Hon.

Operator Training Requirement: Training Time Estimate: 4 Hours

Provide information to aid the operator in performing dynamic response tests, jet firing pattern analysis, detailed system calibration, fault isolation to a card or group of cards, and system and component performance verification.

Block I [X] Block II [ ]

1. Test Console & Test Table
2. Selection, Controlling & Monitoring
3. Electronic Control Assemblies
4. SCS Displays
5. Manual Hand Controls
6. Program Board
7. Power Supply
8. Pulse Generator
9. Stimuli Control
10. Protection Circuitry
11. Voltmeter

Maintenance Training Requirement: Training Time Estimate: 8 Hours

Describe procedures for removal of malfunctioning replaceable packages, installation, recertification, calibration and servicing; visual inspection for frayed and damaged wiring, component damage, loose solder joints, broken parts and foreign matter. Operator training is a prerequisite for maintenance training.

Interface:
1. SCS B/M Auxiliary Equipment, C14-095
2. Facility Electrical Power
3. C14-307 Secondary Attitude Reference System BME (AFRM 009 only, Downey & FF)
4. Power Supply Cables
5. Interconnect Cables

Reason for Revision: Added technical information, Revised Interface & corrected part no. Analyst: C. I. Steele, Ext. 4221, 2 Manufacturer: Minn-Honey.

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Date: August 27, 1964
Rev. Date: December 28, 1964
TADN: G16-858080

O&M GSE TRAINING REQUIREMENT

Model: C14-460

System: Sequencers

Nomenclature: Mission Sequencer Group, BME

Downey:	S/C 6,8,9,11,12,14,15,17, & 20	B/P 14 EDL Support
MSC:	S/C 8 B351 Therm Cham Test	
FF:	S/C 9,11,12,14,15,17, & 20	O&C Building

Interchangeability: N/A

Responsible Engineer: J. M. Pomykata Block I [X] Block II [ ]

Technical Reference:	62T0695-322-1	G16-858088	G16-858091
	SID 62-417	G16-985846	MA 0205-829

Operator Training Requirement: Training Time Estimate: 4 Hours

Explain the procedure for testing the performance and isolating faults of the individual sequencers within the sequencer system, testing of redundant circuits and understand how the BME is manually operated and the operation of the automatic data recording equipment.

1. Control & Display Panels
2. Power Supplies
3. Signal Sources
4. Output Measuring System
5. Simulated Loads
6. Interface Adapter
7. Supply Requirements

Maintenance Training Requirement: Training Time Estimate: 8 Hours

Discuss visual inspection for physical damage, proper component installation and cleanliness; procedures for fault isolation, fault verification, repair; removal and replacement of lights, modules, connectors, terminal boards, wiring and subsequent panel verification. Operator training is a prerequisite for maintenance training.

Interface:

1. Adapter Separation Sequencer
2. Adapter Separation & SPS Abort
3. Tower Sequencers (two types)
4. S/M RCS Control Sequencer
5. Hot Line EDS Abort Converter
6. Power Programmer
7. Mission Sequencer
8. Fuse Box
9. Arm-Safe Control Unit
10. Control Programmer
11. Facility Power

Reason for Revision: Added technical information and revised interface

Analyst: C. I. Steele, Ext. 4221, 2 Manufactured: Tulsa

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APPENDIX D. TYPICAL AMS MALFUNCTION DATA SHEETS FROM AMS MALFUNCTION CATALOG

MIU CODE NO:	AMS MALFUNCTION FORM	DATE:
SYSTEM CODE NO:	SUBSYSTEM: Stabilization & Control System	MATH MOD SYM:

1. MALFUNCTION TITLE:
Seat 1 Rotational Hand Controller normal manual pitch output failure (SCS-019)

2. DESCRIPTION:
Seat 1 Controller provides zero output in pitch channel.

3. EFFECTS ON SUBSYSTEM - IMMEDIATE:
Loss of pitch attitude control for Seat 1.
FINAL:
Loss of normal manual pitch control for Seat 1 controller.
CREW REQUIREMENTS:
Employ direct manual mode for Seat 1 pitch maneuvers.

4. EFFECTS VISIBLE IN C/M - INSTRUMENT AND INDICATION:

A. FDAI ball fails to respond to pitch attitude rotation commands by Seat 1 rotational controller with HAND CONTROLLER DIRECT-ENABLE switch in lower position (4, 16).

B. FDAI rate needle fails to respond to pitch attitude rotation commands by Seat 1 rotational controller with HAND CONTROLLER DIRECT-ENABLE switch in lower position (4, 16).

5. CREW ACTION - INSTRUMENT/CONTROL AND ACTION:

A. Place HAND CONTROLLER DIRECT-ENABLE switch to upper position (16) (See note 1).

B. Control vehicle attitude with rotational hand controller.'

6. EFFECTS VISIBLE AT IOS - INSTRUMENT AND INDICATION:

7. EFFECTS TRANSMITTED VIA DOWN T/M - SENSOR AND INDICATION:

8. REMARKS: Initial Condition: Any of the CONTROL MODE SELECT modes selected. Phase: Translunar, lunar orbit, transearth, and entry phases. Note 1: With SCS in manual direct mode, attitude rates should be kept low to conserve RCS fuel. Note 2: Additional skill is required to control vehicle in manual direct mode.

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MIU CODE NO:	AMS MALFUNCTION FORM	DATE:
SYSTEM CODE NO:	SUBSYSTEM: Electrical Power System	MATH MOD SYM:

1. MALFUNCTION TITLE:
Inverter 1 failure (EPS 076)

2. DESCRIPTION: Inverter 1 output rises causing overvoltage on AC Bus 1 and AC Bus 2, disconnect from buses.

3. EFFECTS ON SUBSYSTEM - IMMEDIATE: Loss of power to all electrical equipment connected to AC Bus 1 and AC Bus 2.

FINAL:
Loss of Inverter 1

CREW REQUIREMENTS:

4. EFFECTS VISIBLE IN C/M - INSTRUMENT AND INDICATION:

1. AC VOLTS indicator reads high with AC INDICATORS switch in ϕA, ϕB, and ϕC Bus 1 and Bus 2 positions (18). (See Note 1).
2. AC Bus 1 FAIL light illuminates (11).
3. AC Bus 2 FAIL light illuminates (11).
4. MASTER CAUTION light illuminates (3, 18, LEB).
5. Audio tone in headsets.
6. AC VOLTS indicator reads low with AC INDICATORS switch in ϕA, ϕB, and ϕC Bus 1 and Bus 2 positions (18).

5. CREW ACTION - INSTRUMENT/CONTROL AND ACTION:

1. Depress MASTER CAUTION light (3, 18)
2. Place FUEL CELL PUMPS NO. 1, FUEL CELL PUMPS NO, 2, and FUEL CELL PUMPS NO. 3 switches on OFF (22).
3. Place SUIT COMP switch to OFF (21).
4. Place AC INVERTER 2 switch to ON (18) (See note 2).
5. Place AC INVERTER 2 AC Bus 1 switch to ON (18).
6. Place AC INVERTER 2 AC Bus 2 switch to ON (18).
7. Place AC INVERTER 1 switch to OFF (18).
8. Place AC INVERTER 1 AC Bus 1 switch to OFF (18).
9. Place AC INVERTER 1 AC Bus 2 switch to OFF (18).
10. Place AC Bus 1 reset switch to RESET (18).
11. Place AC Bus 2 reset switch to RESET (18).
12. Position AC indicators switch to ϕA, ϕB, and ϕC Bus 1 and Bus 2 positions and check AC indicator and frequency indicator (18).
13. Place FUEL CELL PUMPS NO. 1 switch to Bus 1 (22).

6. EFFECTS VISIBLE AT IOS - INSTRUMENT AND INDICATION:

7. EFFECTS TRANSMITTED VIA DOWN T/M - SENSOR AND INDICATION:

1. AC voltage main Bus 1 phase A (CC 0200 V)
2. AC voltage main Bus 1 phase B (CC 0201 V)
3. AC voltage main Bus 1 phase C (CC 0202 V)
4. AC voltage main Bus 2 phase A (CC 0203 V)
5. AC voltage main Bus 2 phase B (CC 0204 V)
6. AC voltage main Bus 2 phase C (CC 0205 V)
7. Frequency AC Bus 1 phase A (CC 0213 F)
8. Frequency AC Bus 2 phase A (CC 0217 F)

8. REMARKS: Initial condition: Inverter 1 connected to AC Bus 1 and AC Bus 2, Note 1: Events listed in order of probable occurrence. Note 2: Allow 5 seconds for inverter warm-up before connecting to Bus.

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